US011840061B2

(12) United States Patent

Ohashi et al.

(10) Patent No.: US 11,840,061 B2

(45) Date of Patent: Dec. 12, 2023

(54) **HANDHELD PRINTING APPARATUS**

(71) Applicant: **CANON KABUSHIKI KAISHA**, Tokyo (JP)

(72) Inventors: **Tetsuyo Ohashi**, Kanagawa (JP); **Hiroshi Nakai**, Kanagawa (JP)

(73) Assignee: **Canon Kabushiki Kaisha**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **17/814,763**

(22) Filed: **Jul. 25, 2022**

(65) **Prior Publication Data**

US 2023/0034722 A1 Feb. 2, 2023

(30) **Foreign Application Priority Data**

Jul. 30, 2021 (JP) 2021-125317

(51) **Int. Cl.**

B41J 3/36 (2006.01)
B41J 11/00 (2006.01)
B41J 3/28 (2006.01)
B41J 2/045 (2006.01)

(52) **U.S. Cl.**

CPC ***B41J 3/36*** (2013.01); ***B41J 2/04505*** (2013.01); ***B41J 3/28*** (2013.01); ***B41J 11/0045*** (2013.01)

(58) **Field of Classification Search**

CPC ... B41J 3/36; B41J 3/28; B41J 2/04505; B41J 11/0045

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,013,528	B2 *	4/2015	Takahashi	B41J 29/04 347/171
10,518,560	B2 *	12/2019	Ando	B41J 2/325
11,117,389	B2 *	9/2021	Harada	B41J 3/36

FOREIGN PATENT DOCUMENTS

JP	2019089240 A	6/2019

* cited by examiner

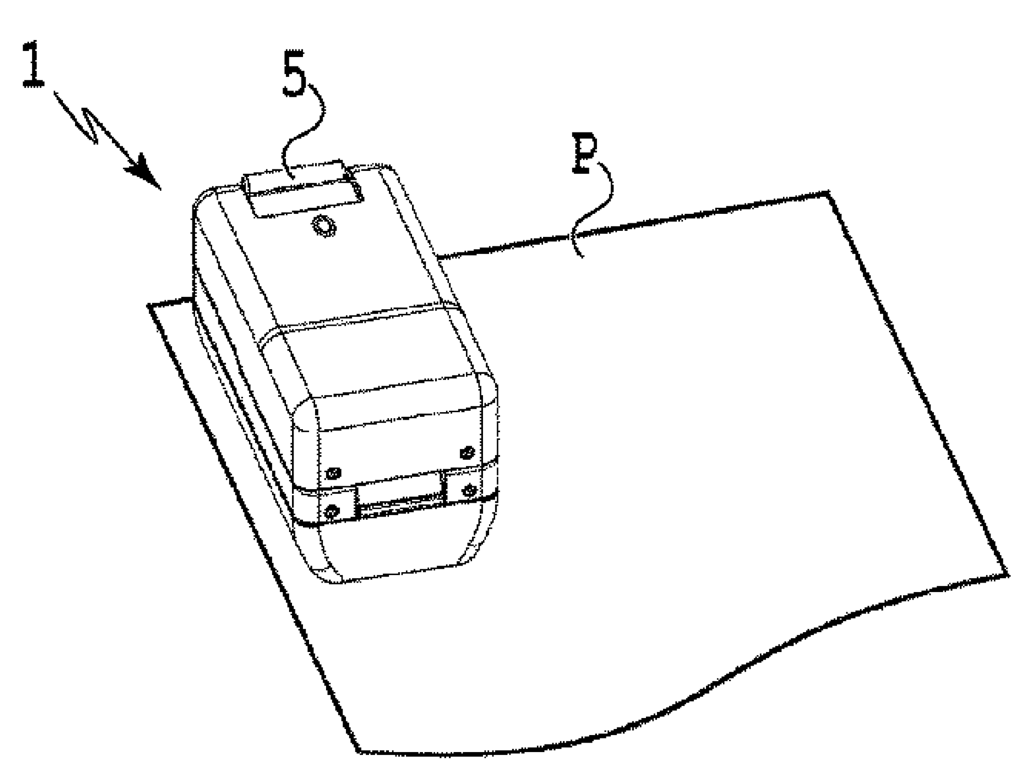
Primary Examiner — Kristal Feggins

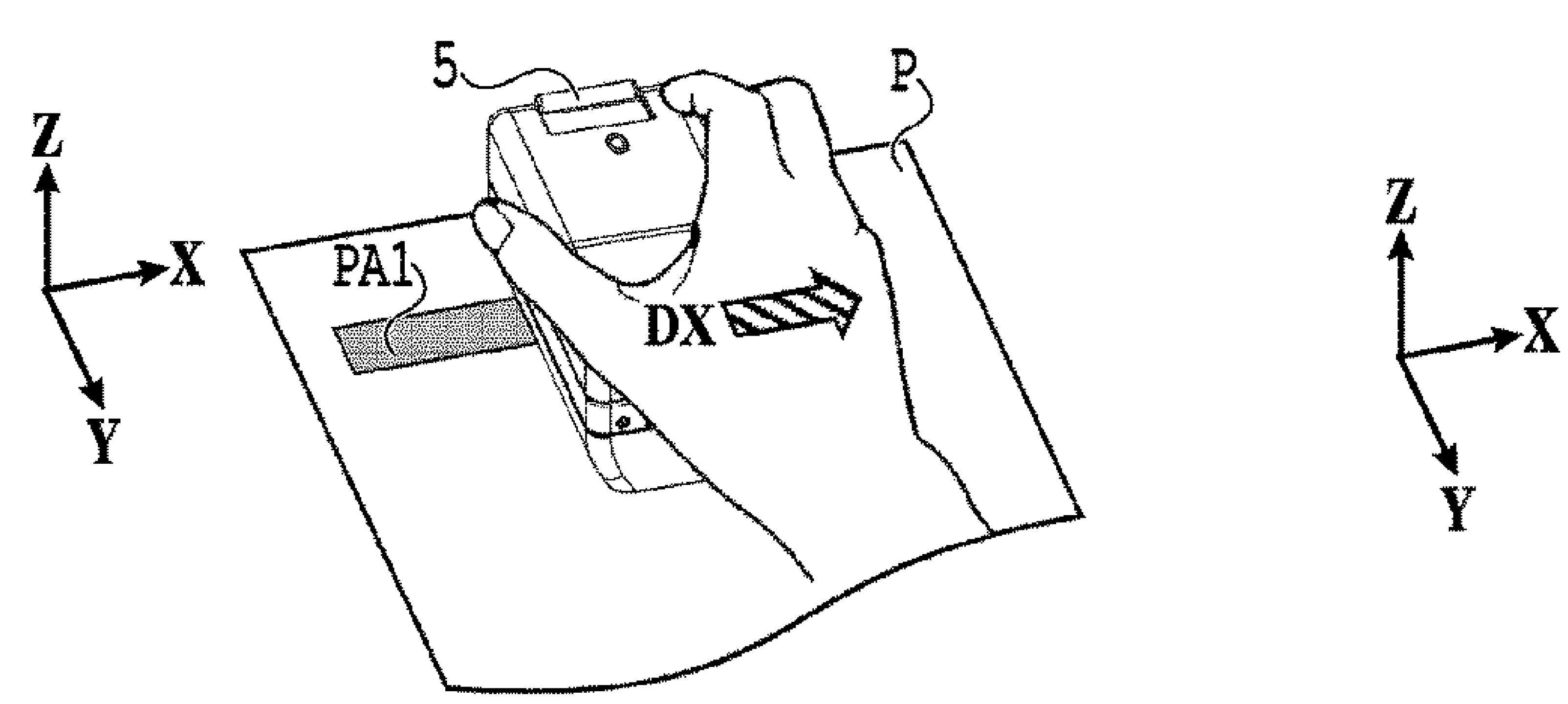
(74) *Attorney, Agent, or Firm* — Canon U.S.A., Inc. IP Division

(57) **ABSTRACT**

Provided is a manually moved printing apparatus capable of suppressing deterioration in printing quality even if the printing apparatus is lifted or tilted. To provide this, a Y-direction sensor support shaft formed integrally with a downstream position detection sensor case and having a rotation axis in the direction of arrows is rotatably supported by a downstream sensor case support arm.

11 Claims, 13 Drawing Sheets





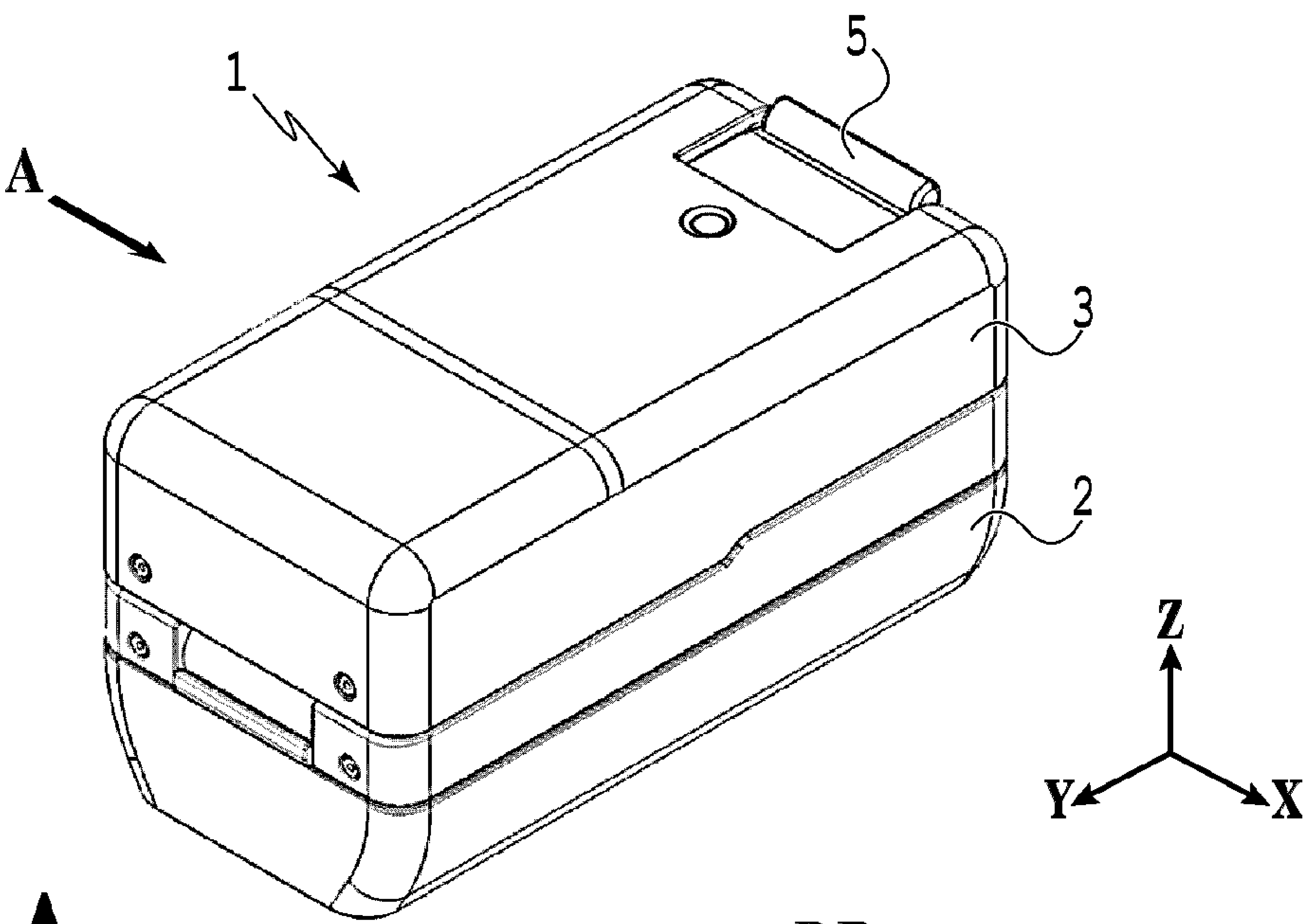

1
5
A
3
2
Z
Y
X

FIG.1A

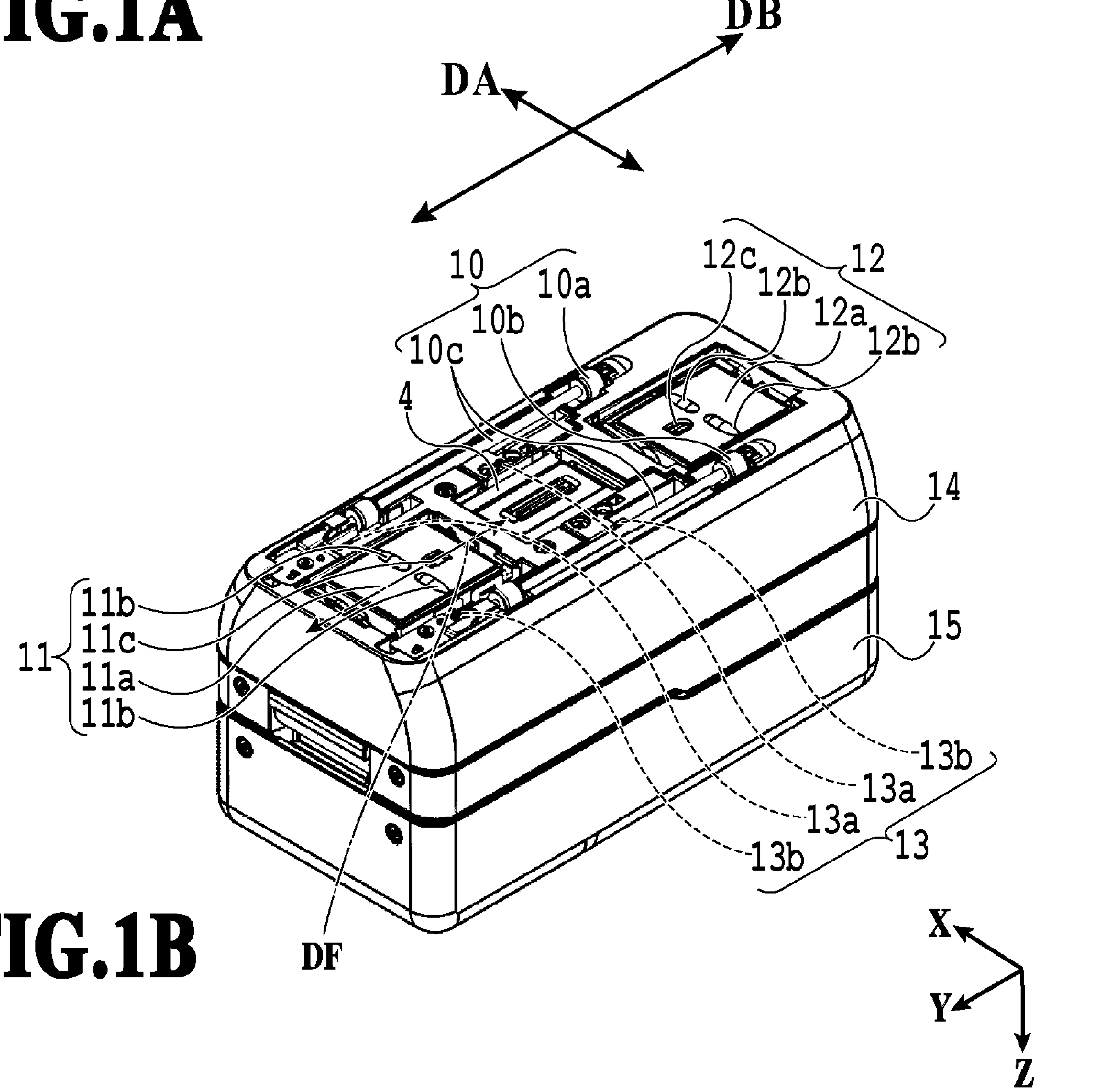

DB
DA
10
10a
10b
10c
4
12c
12b
12
12a
12b
14
15
11
11b
11c
11a
11b
13b
13a
13a
13b
13
DF
X
Y
Z

FIG.1B

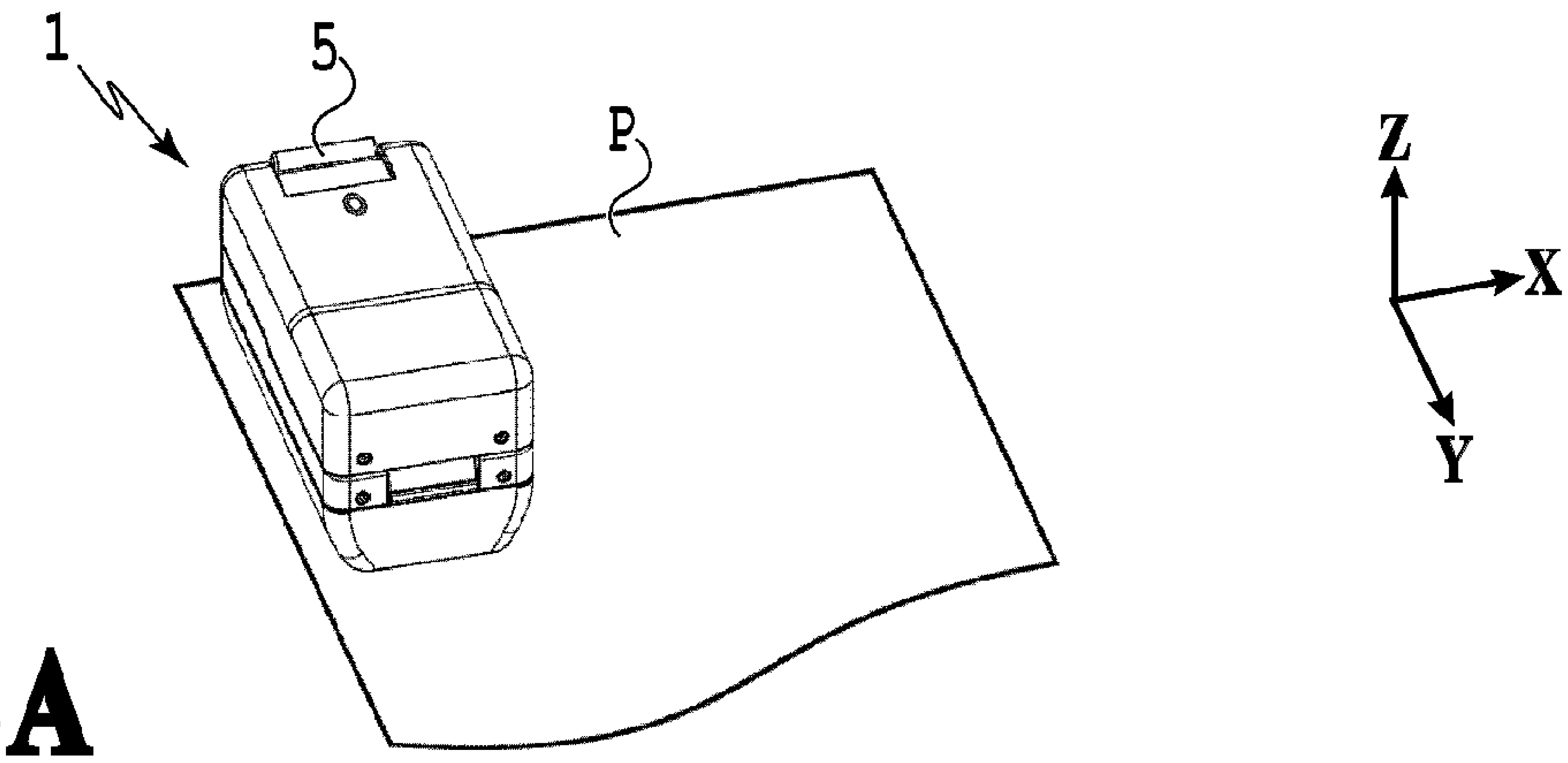


FIG.2A

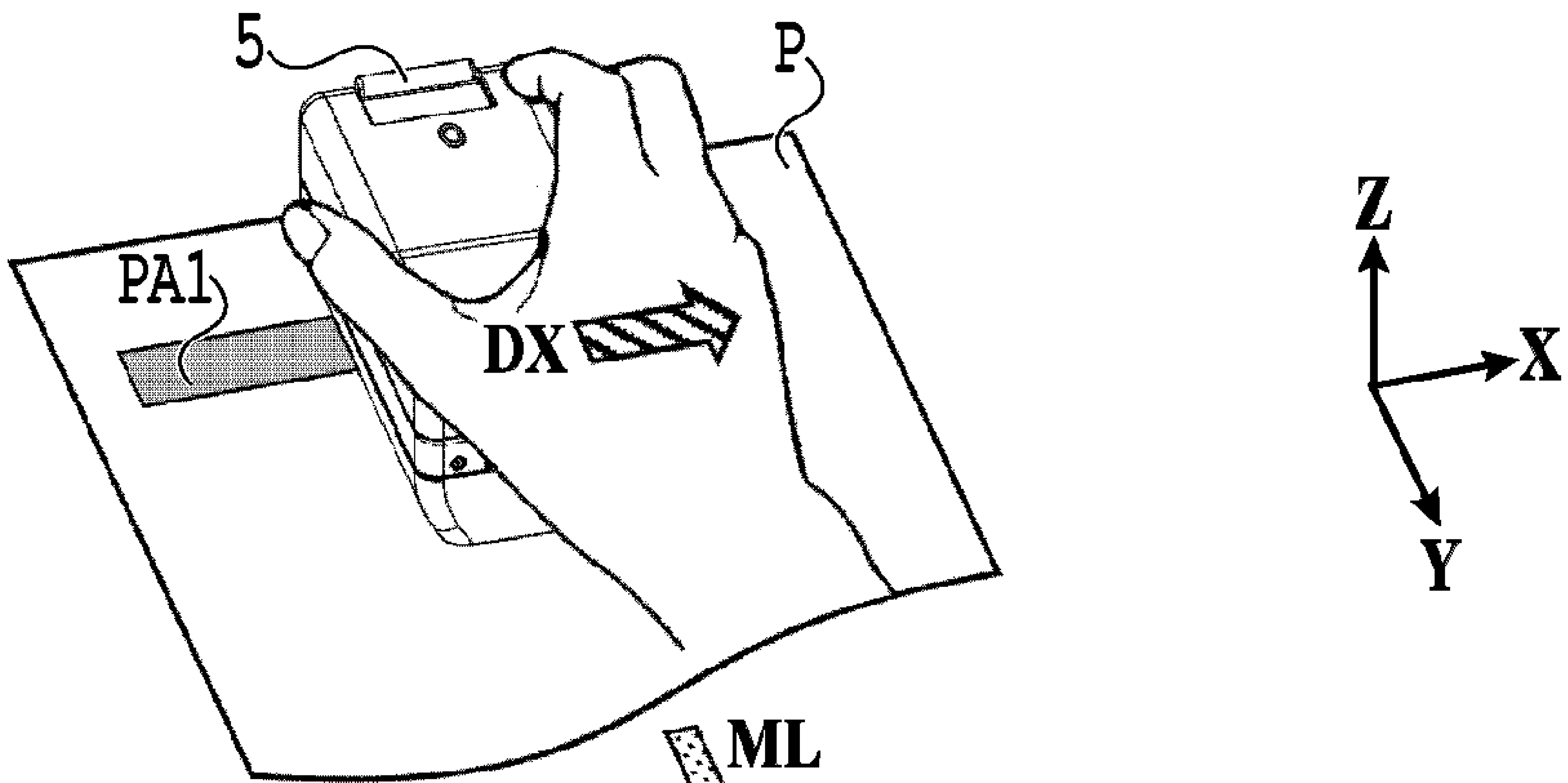


FIG.2B

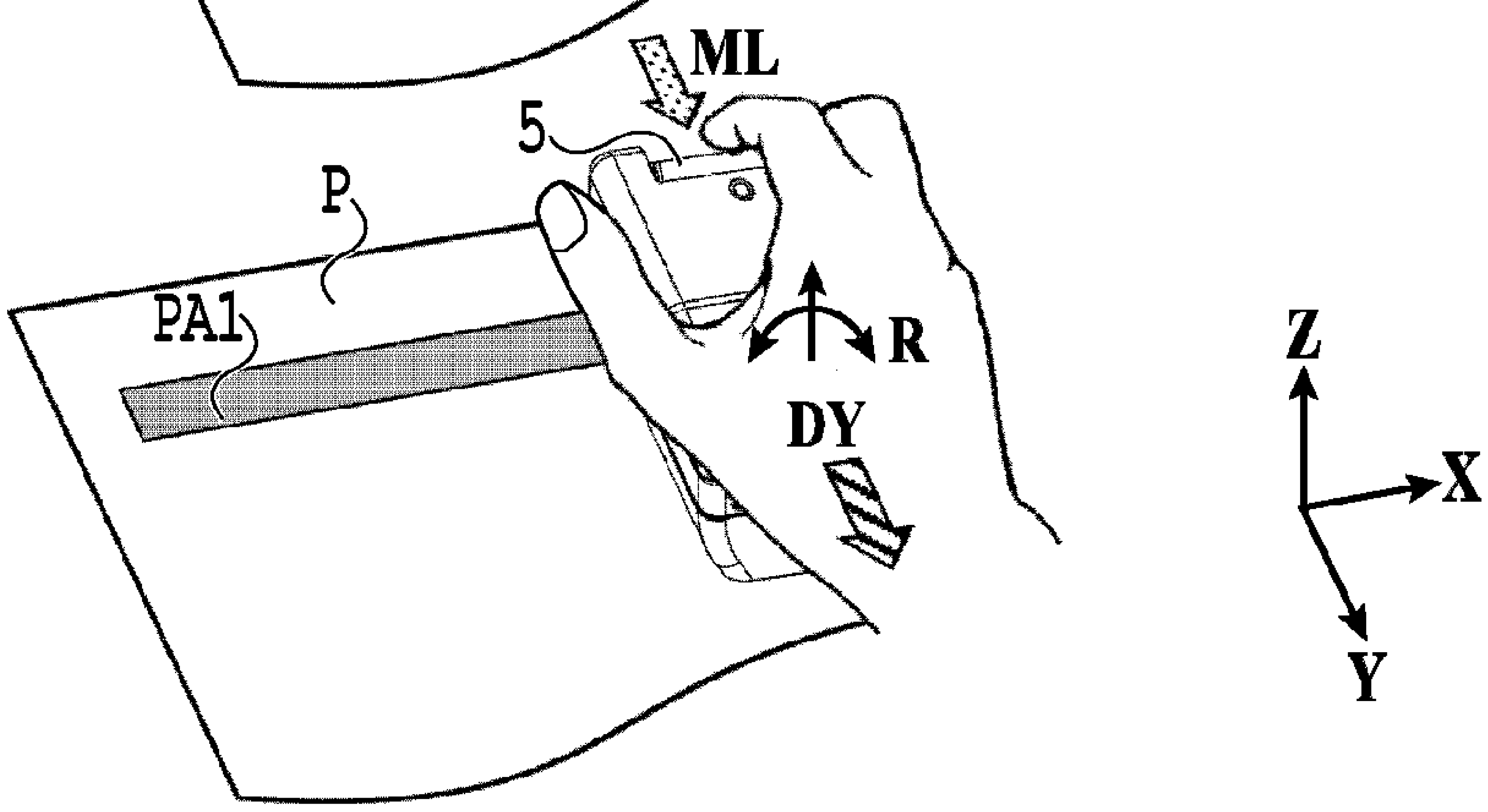


FIG.2C

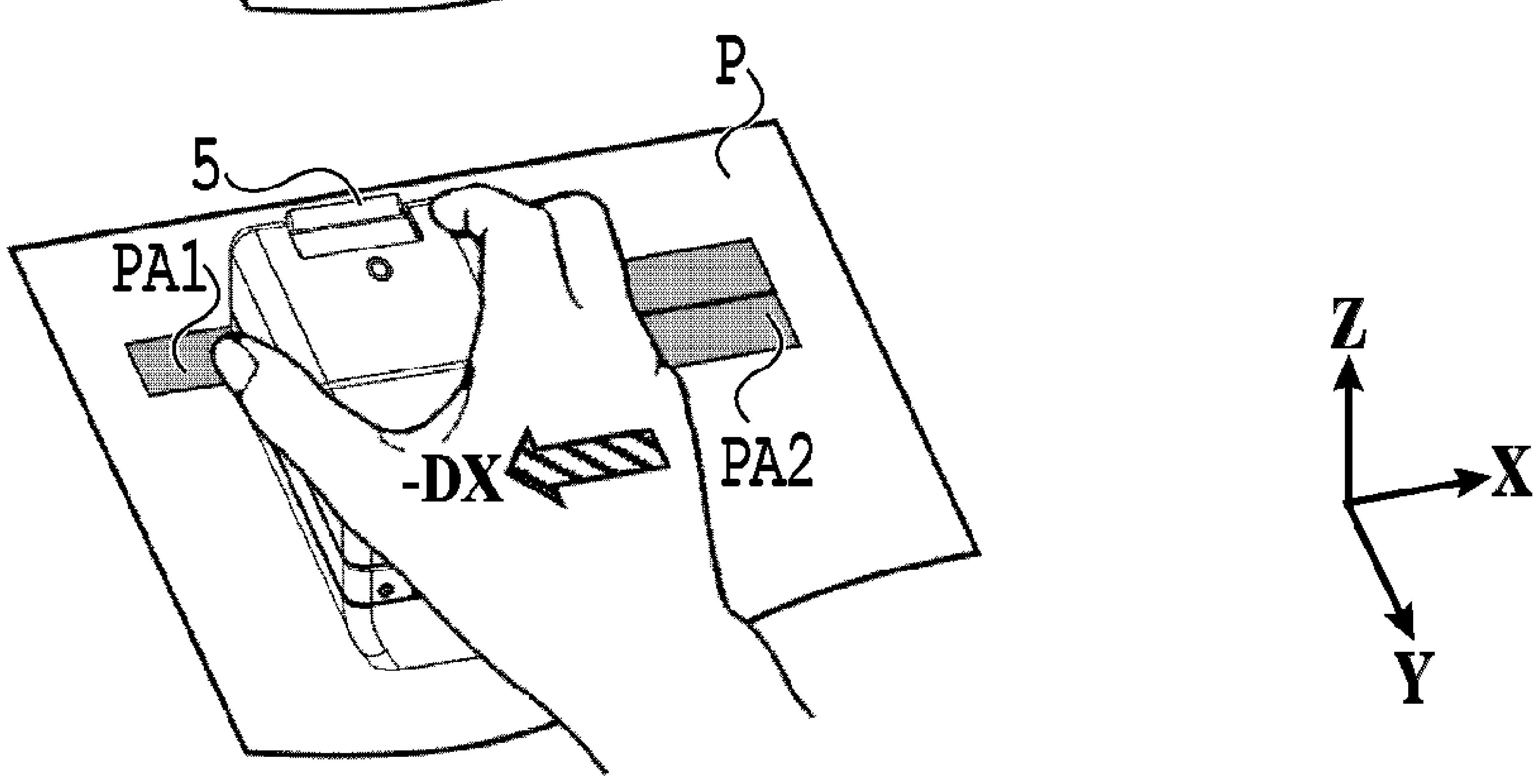


FIG.2D

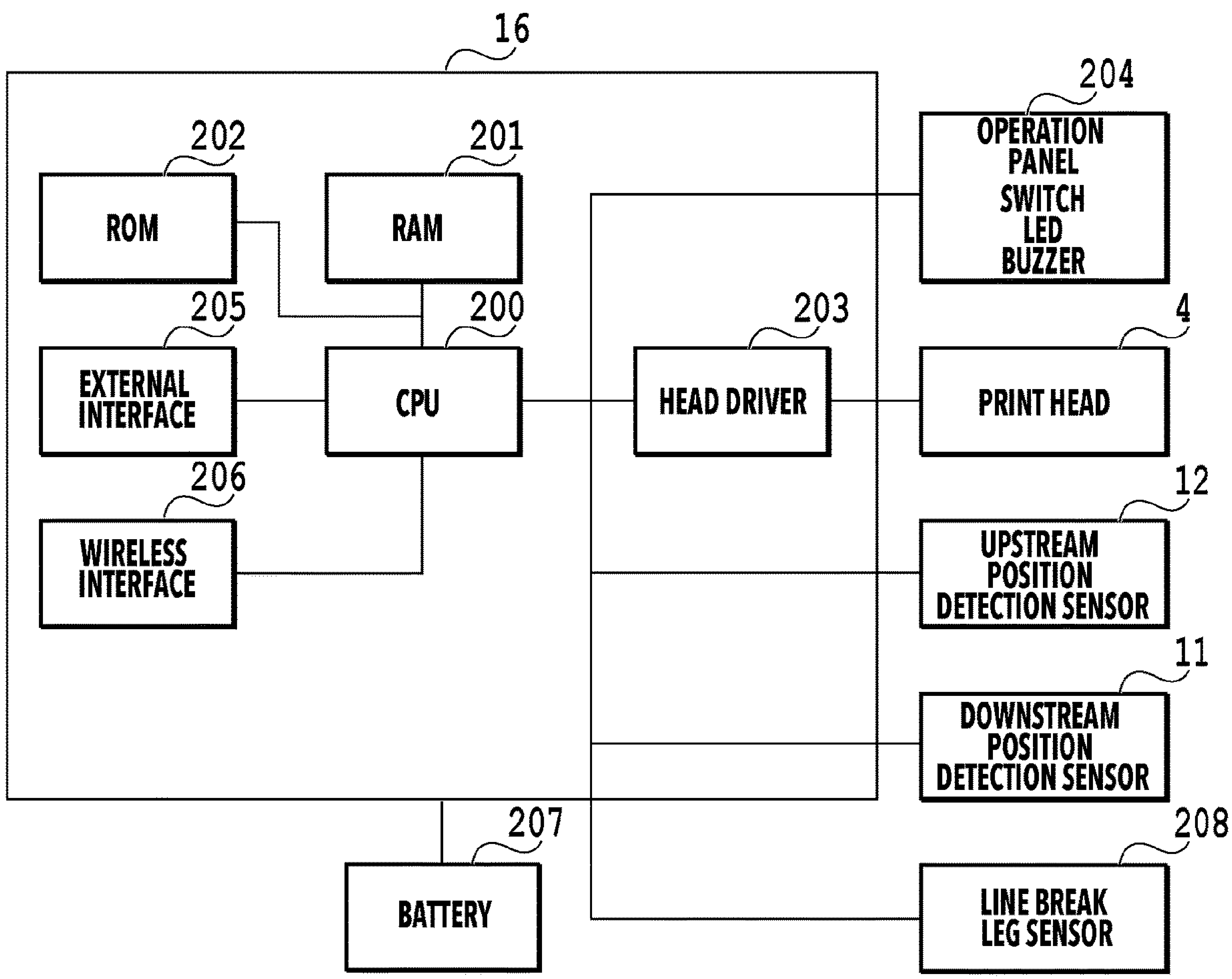

16
202
ROM
201
RAM
205
EXTERNAL INTERFACE
200
CPU
206
WIRELESS INTERFACE
204
OPERATION PANEL
SWITCH
LED
BUZZER
203
HEAD DRIVER
4
PRINT HEAD
12
UPSTREAM POSITION DETECTION SENSOR
11
DOWNSTREAM POSITION DETECTION SENSOR
207
BATTERY
208
LINE BREAK LEG SENSOR

FIG.3

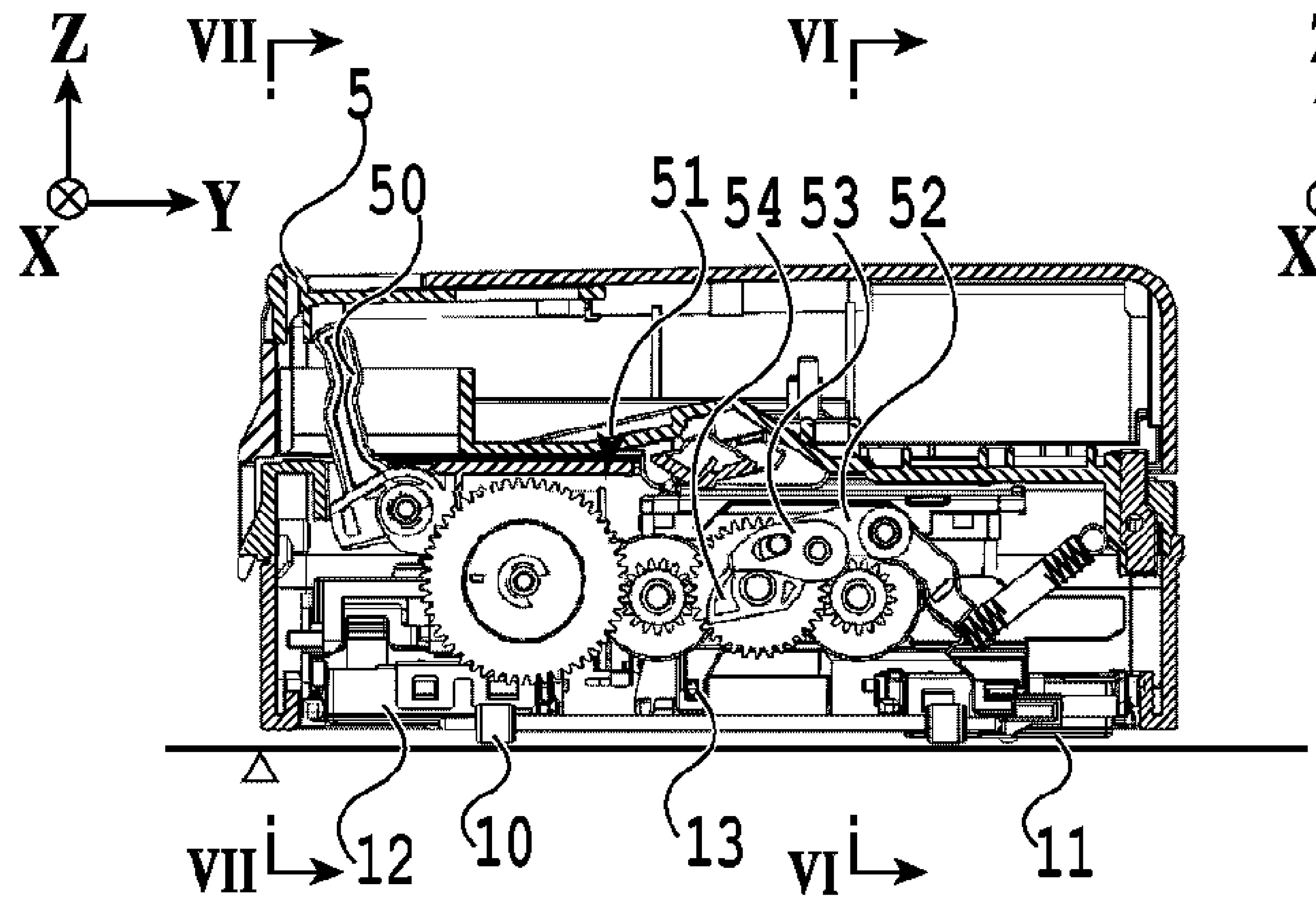


FIG.4A

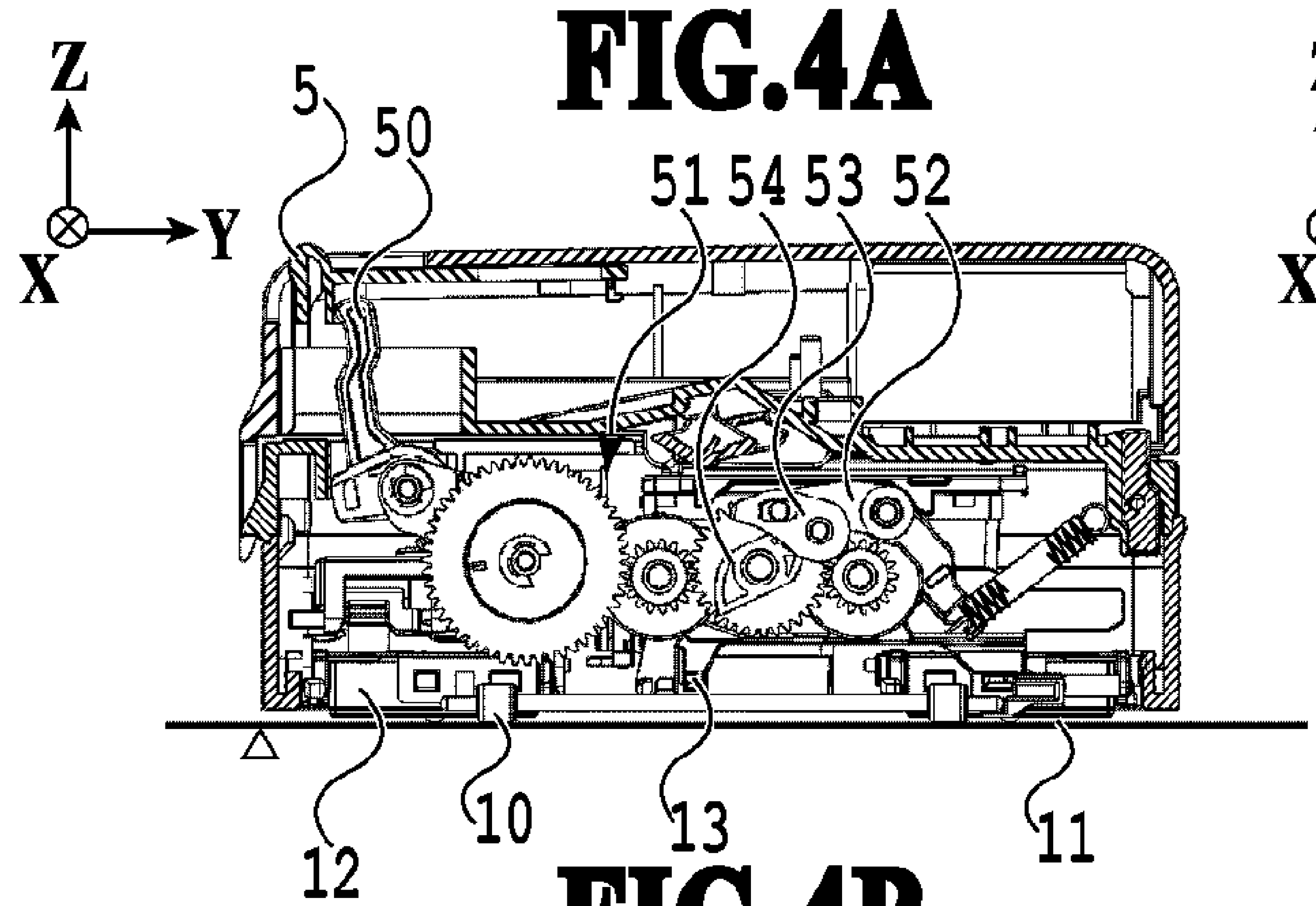


FIG.4B

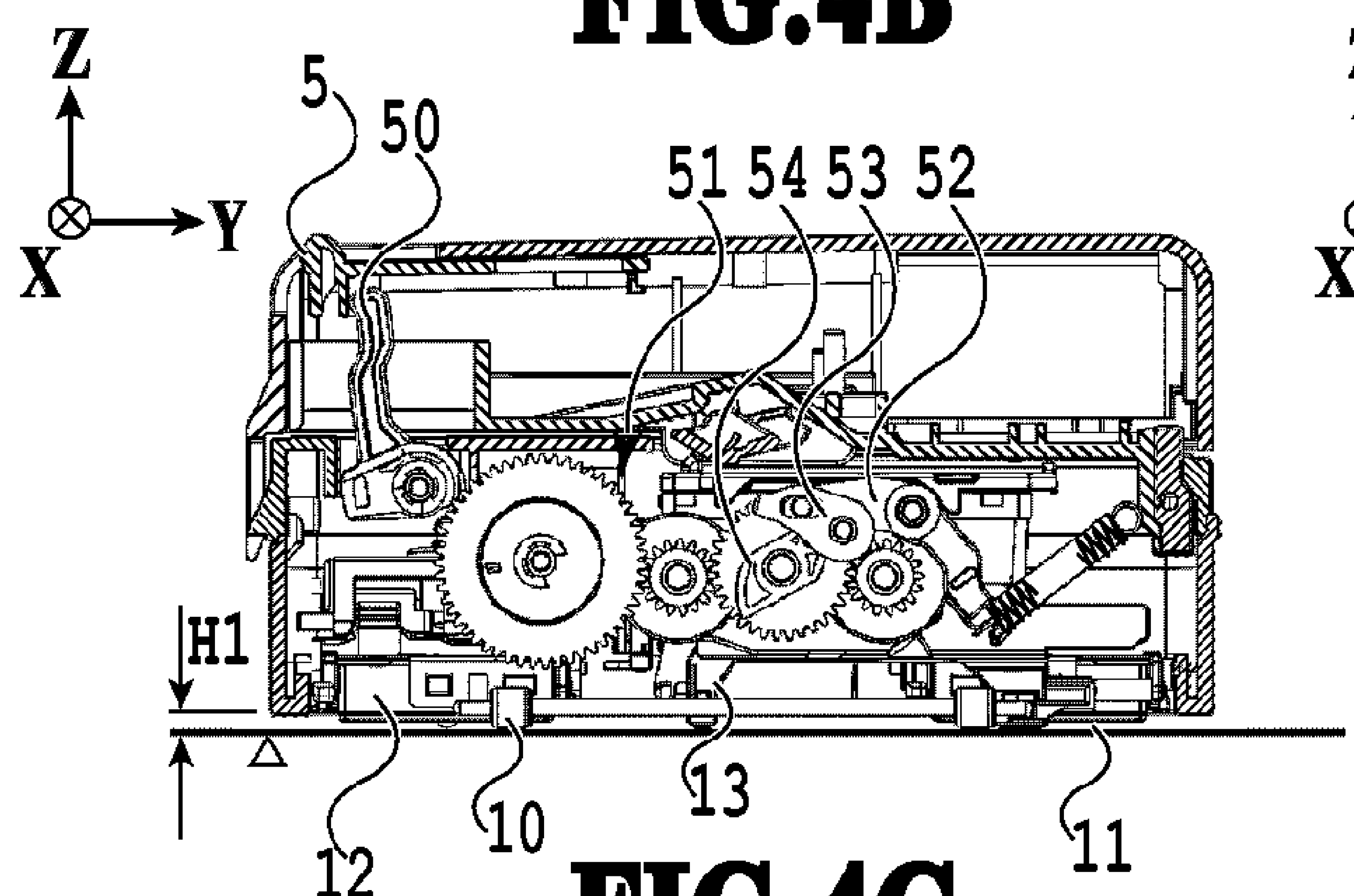


FIG.4C

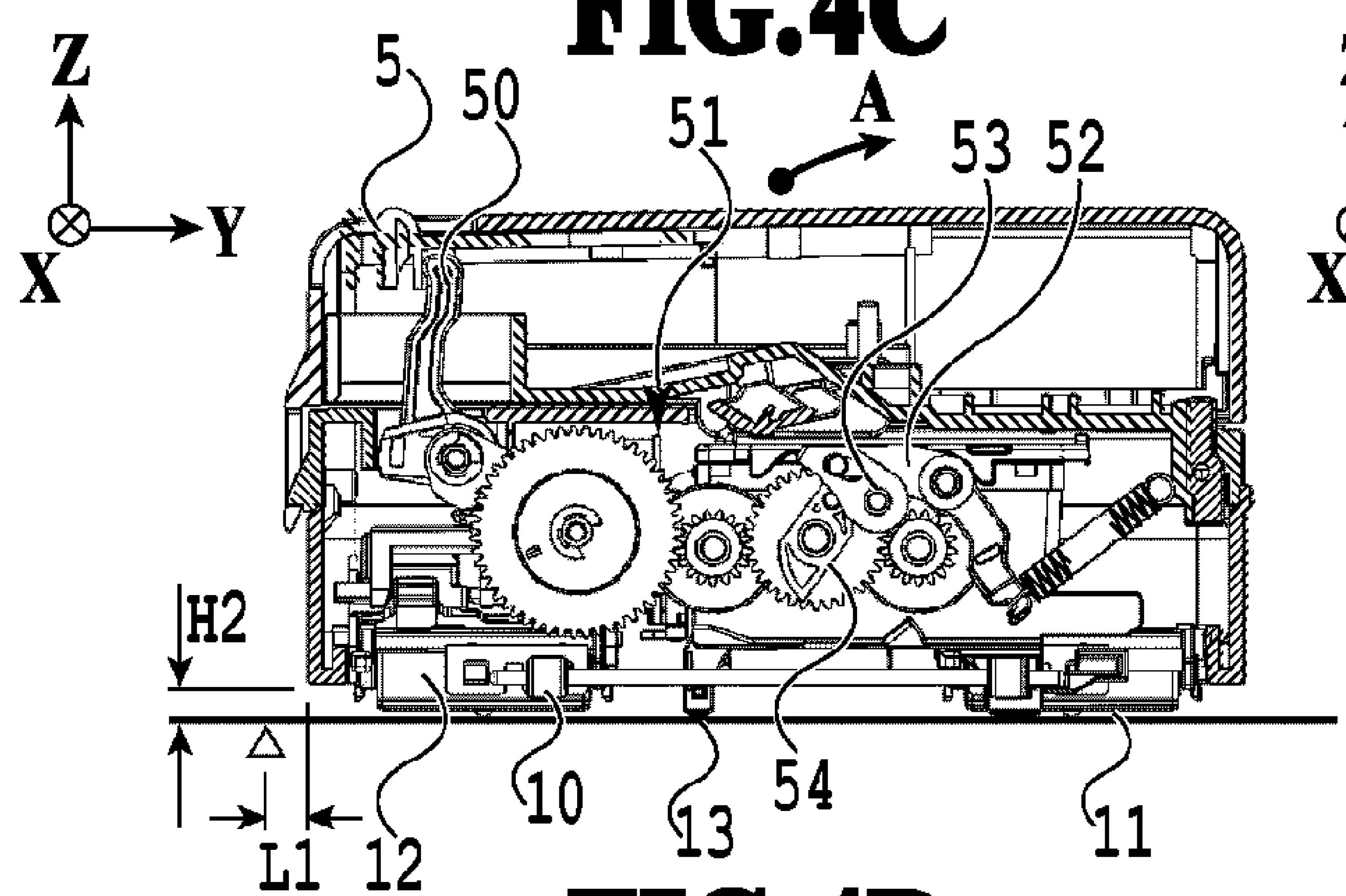


FIG.4D

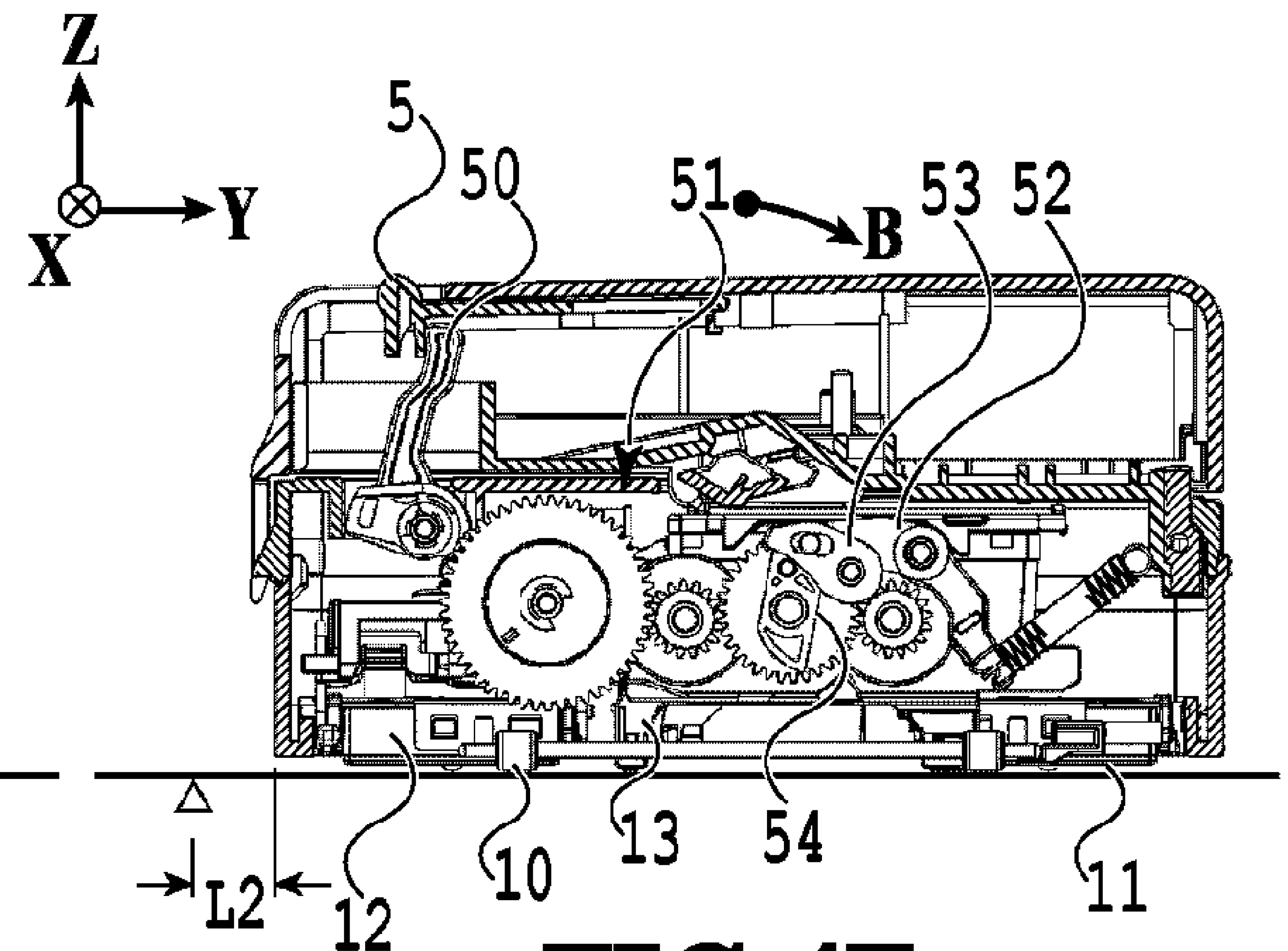


FIG.4E

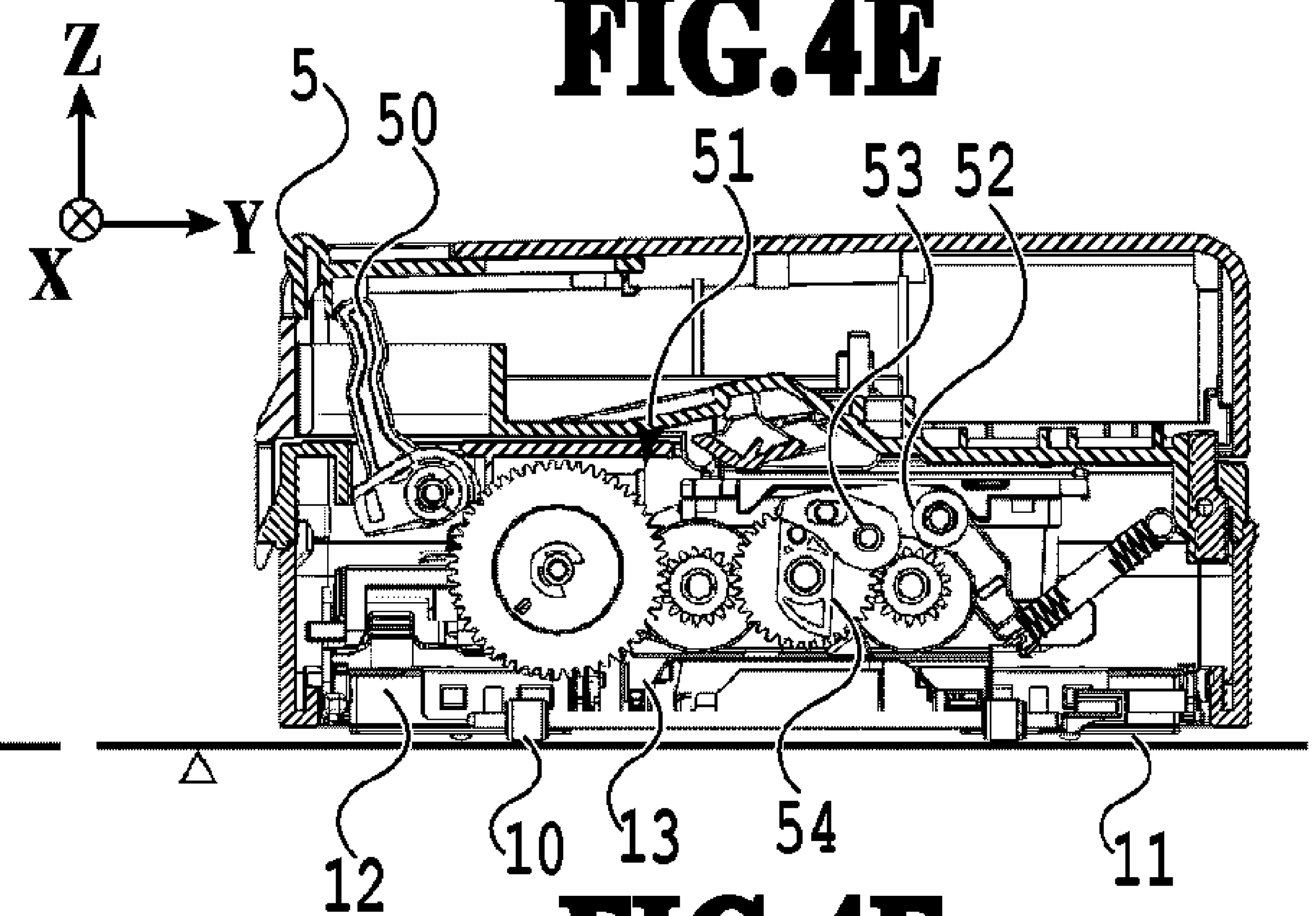


FIG.4F

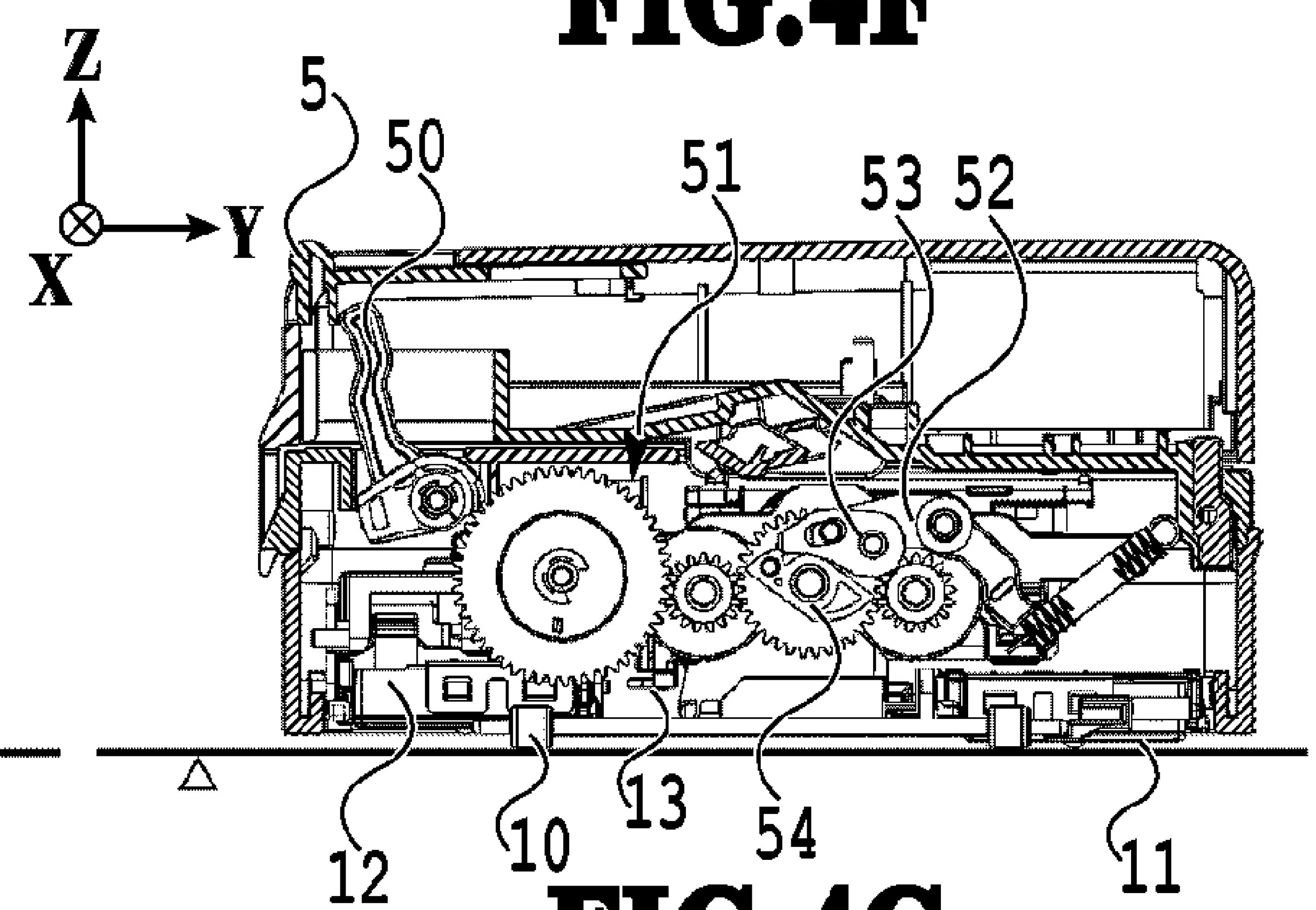


FIG.4G

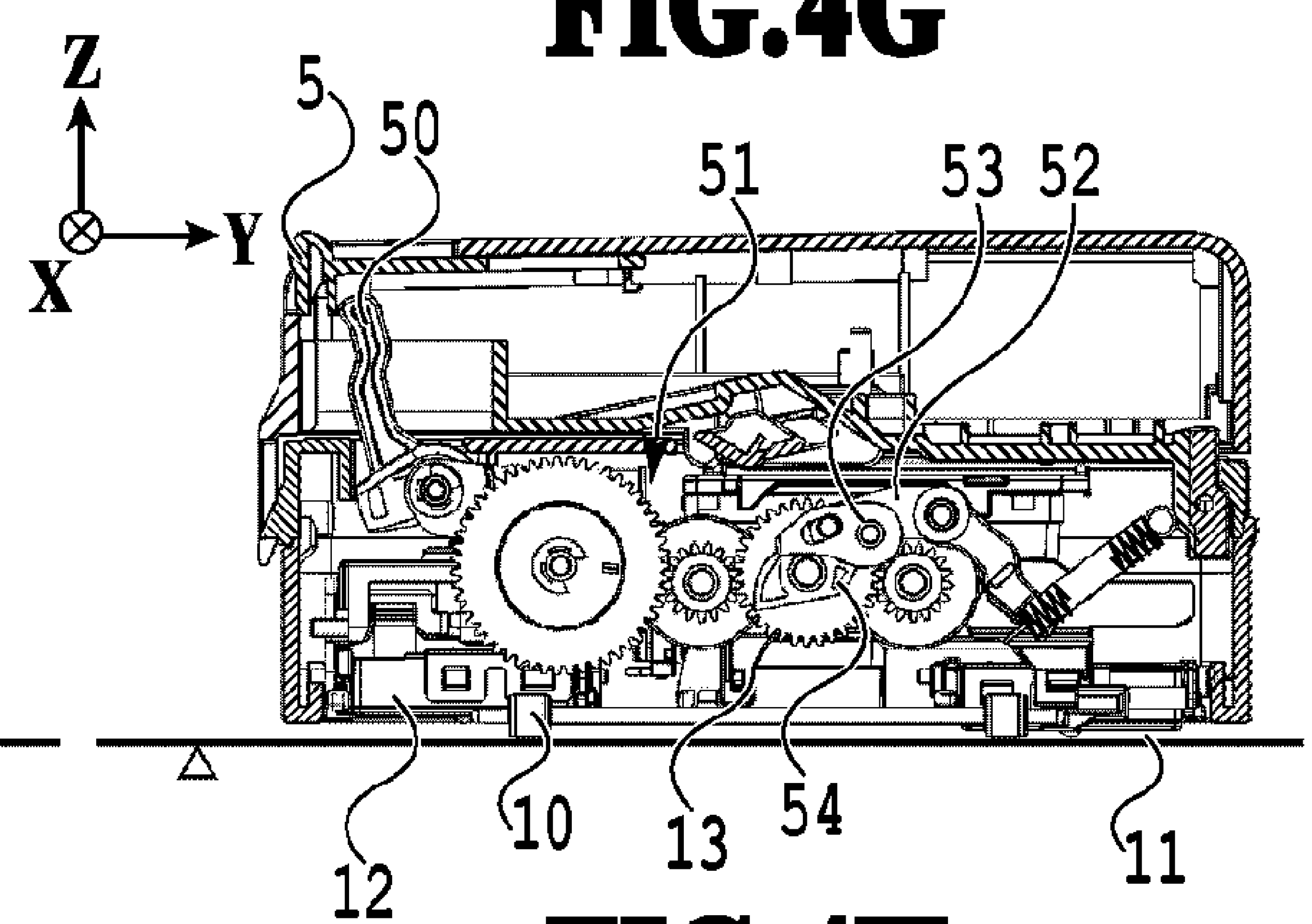


FIG.4H

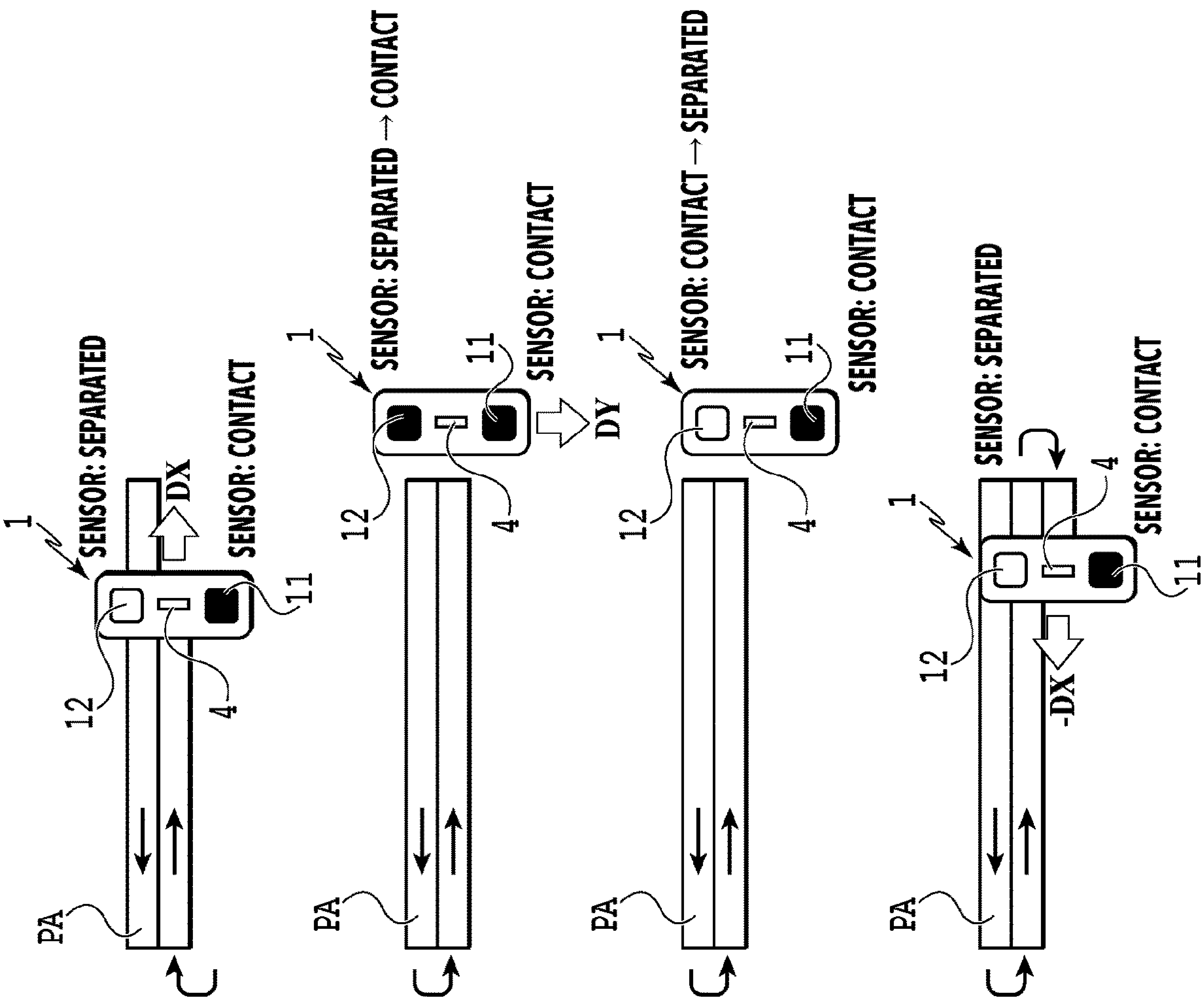


FIG.5A PRINTING

FIG.5B LINE BREAK STARTS

FIG.5C LINE BREAK ENDS

FIG.5D PRINTING

FIG.6A

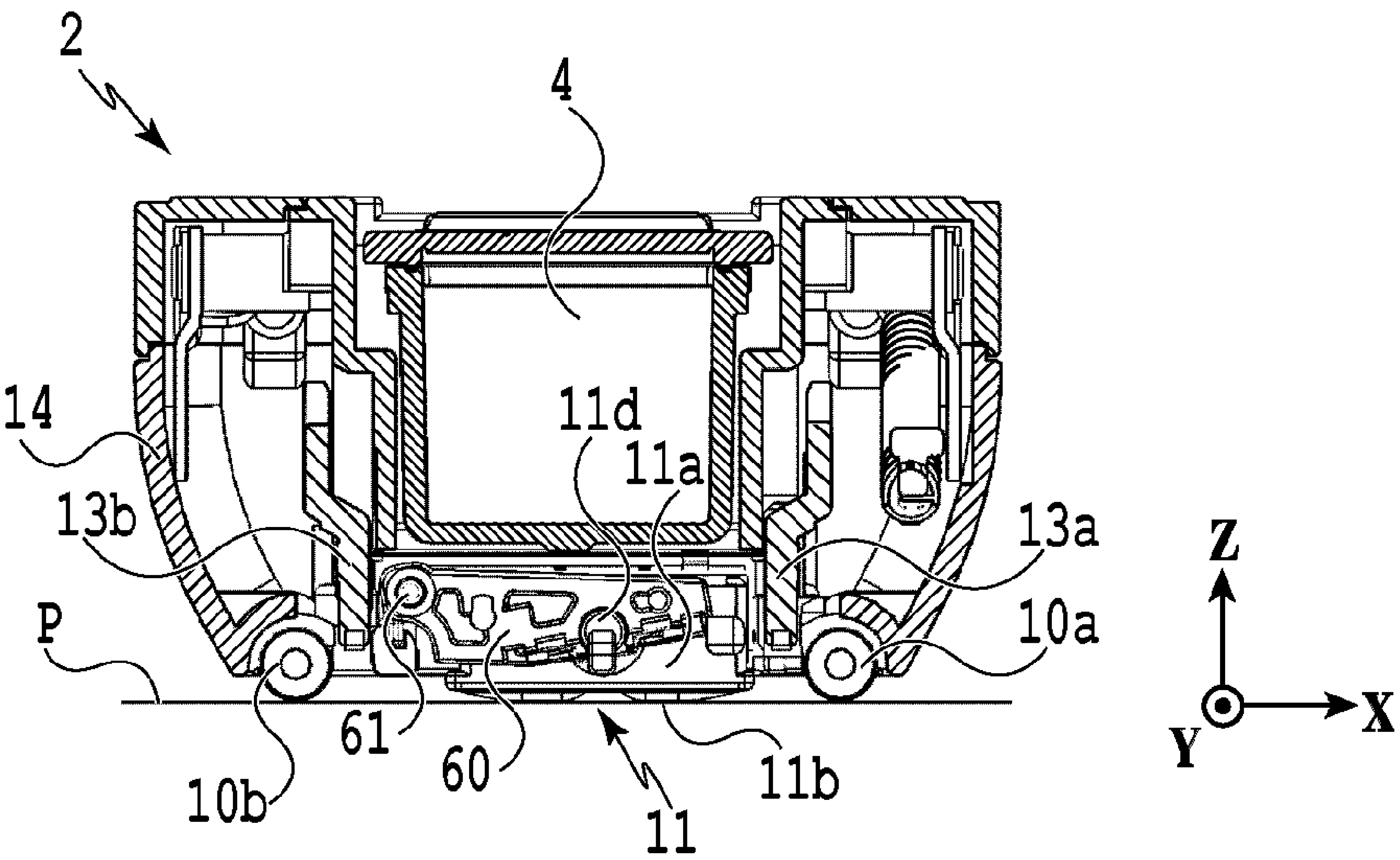
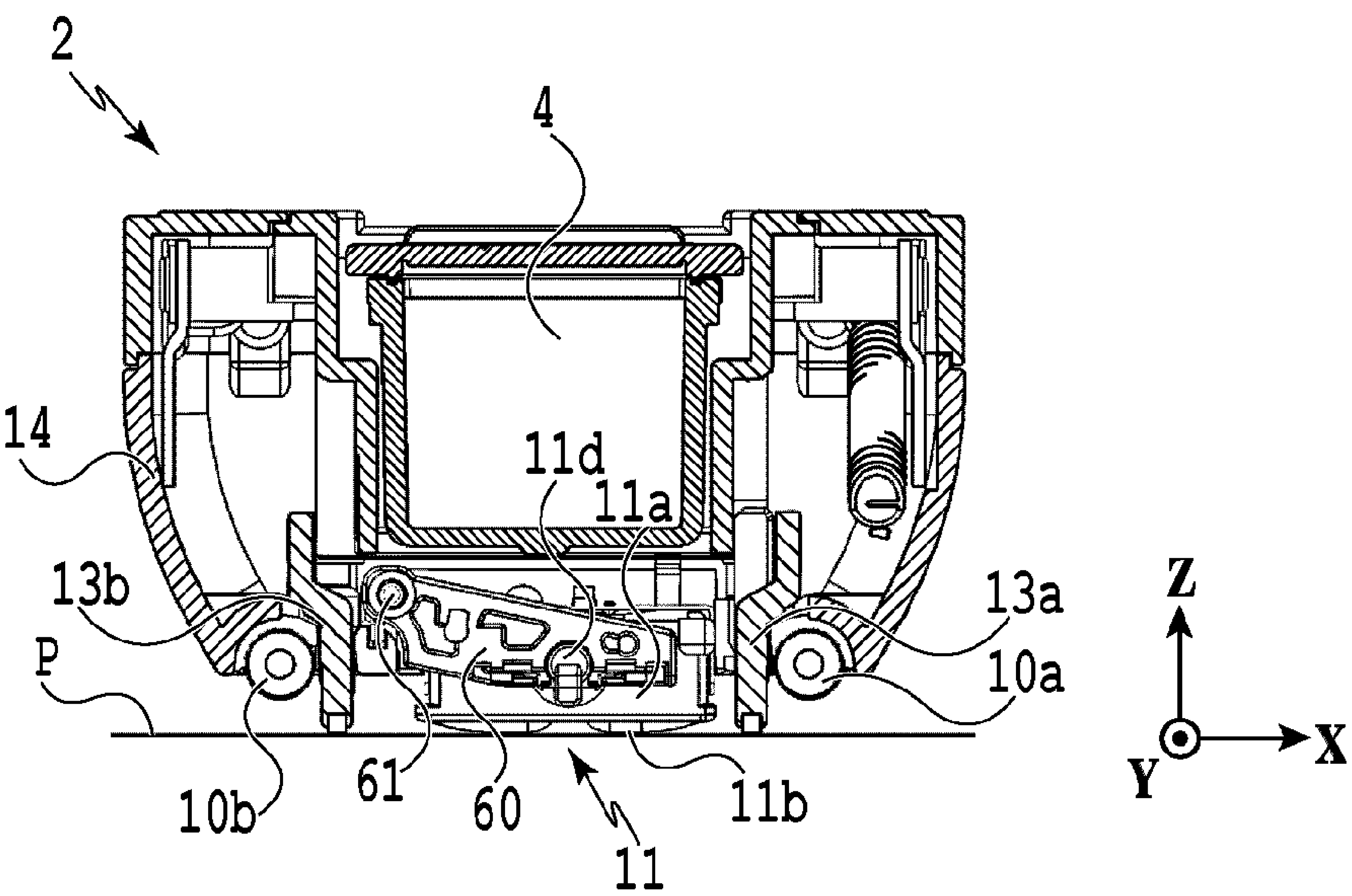

2
4
14
11d
11a
13b
13a
P
10a
61
60
11b
10b
11
Z
X
Y

FIG.6B


2
4
14
11d
11a
13b
13a
P
10a
10b
61
60
11b
11
Z
X
Y

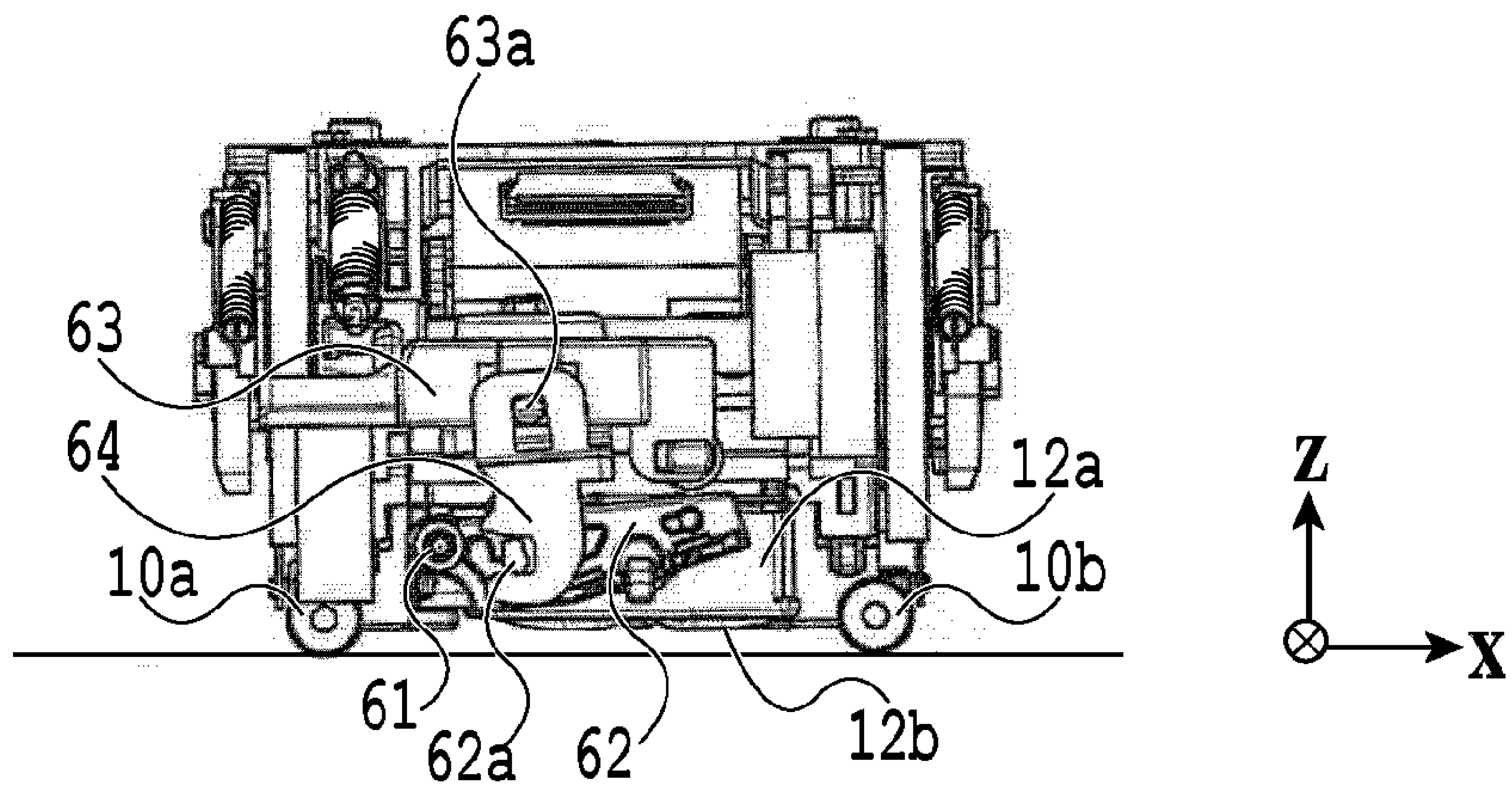


FIG.7A

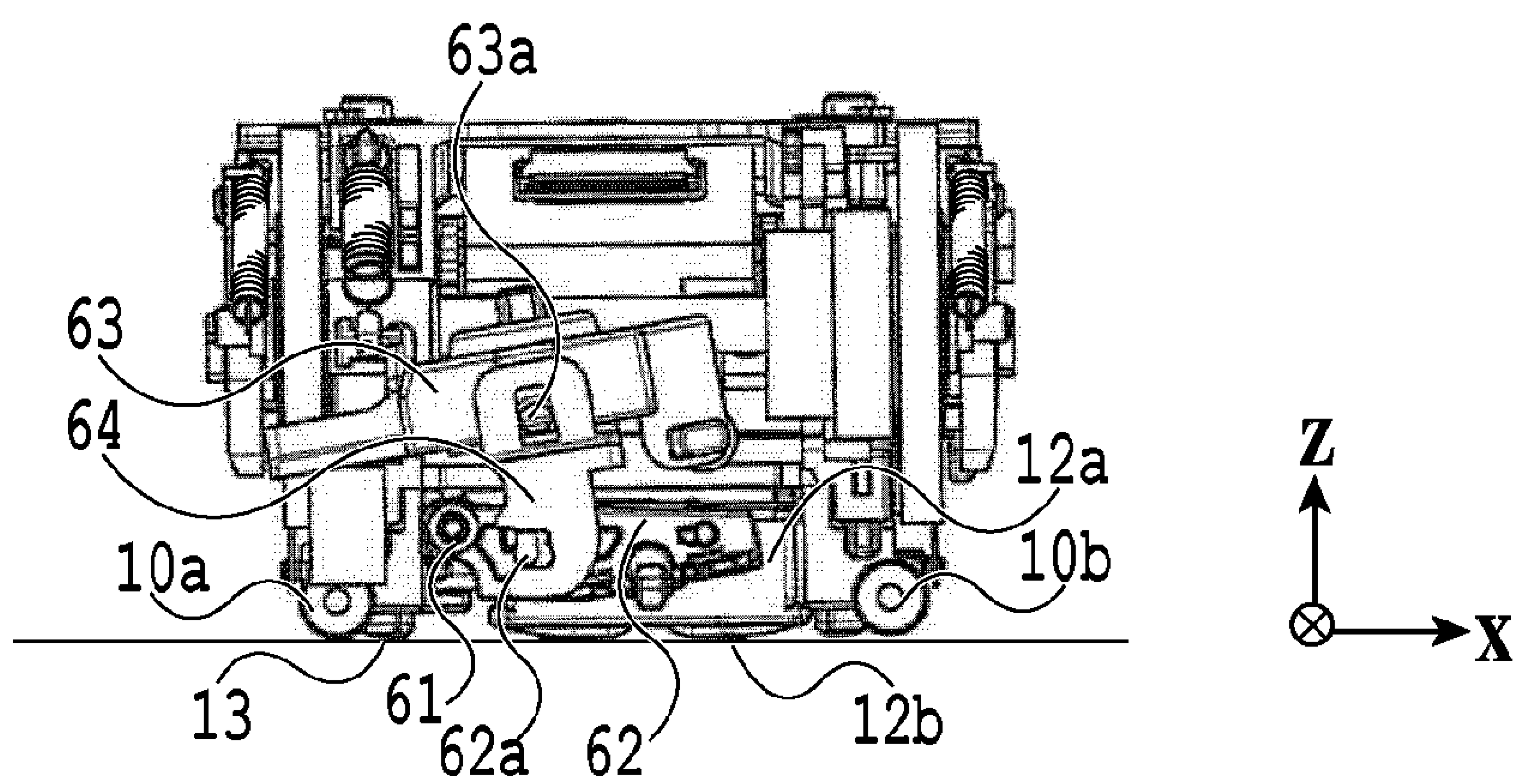


FIG.7B

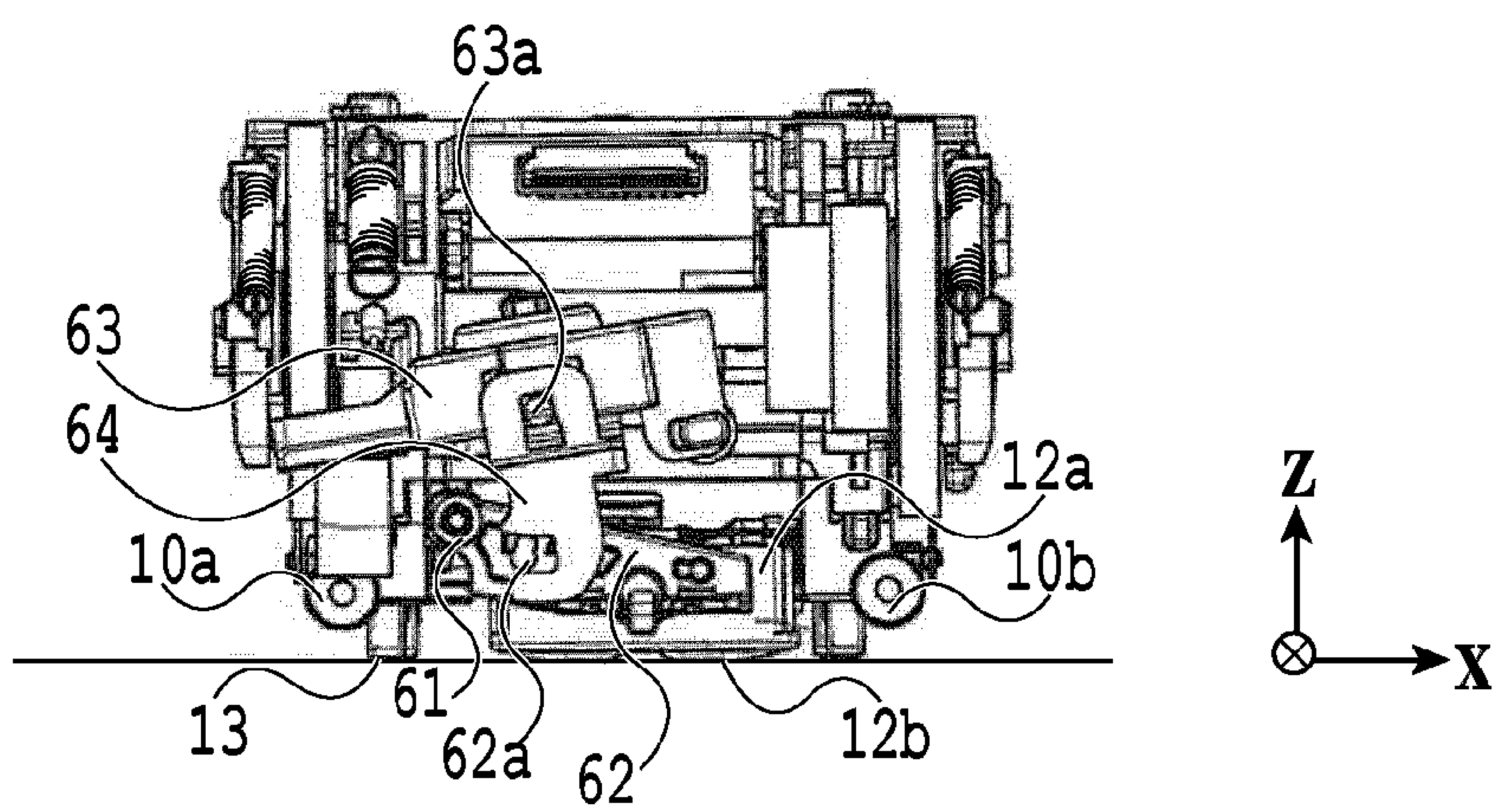


FIG.7C

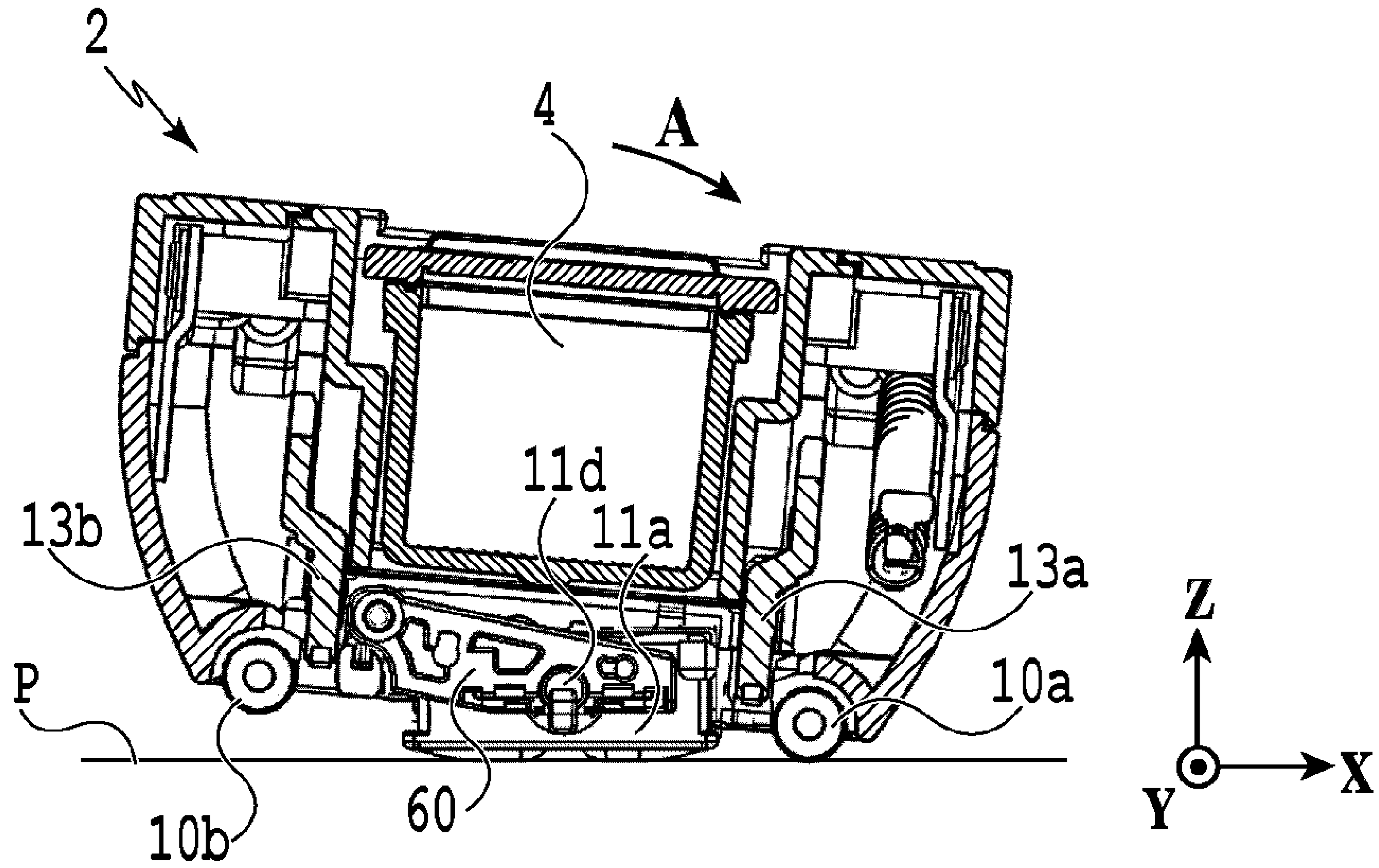

2
4
A
11d
11a
13b
13a
P
10a
10b
60
Z
X
Y

FIG.8A

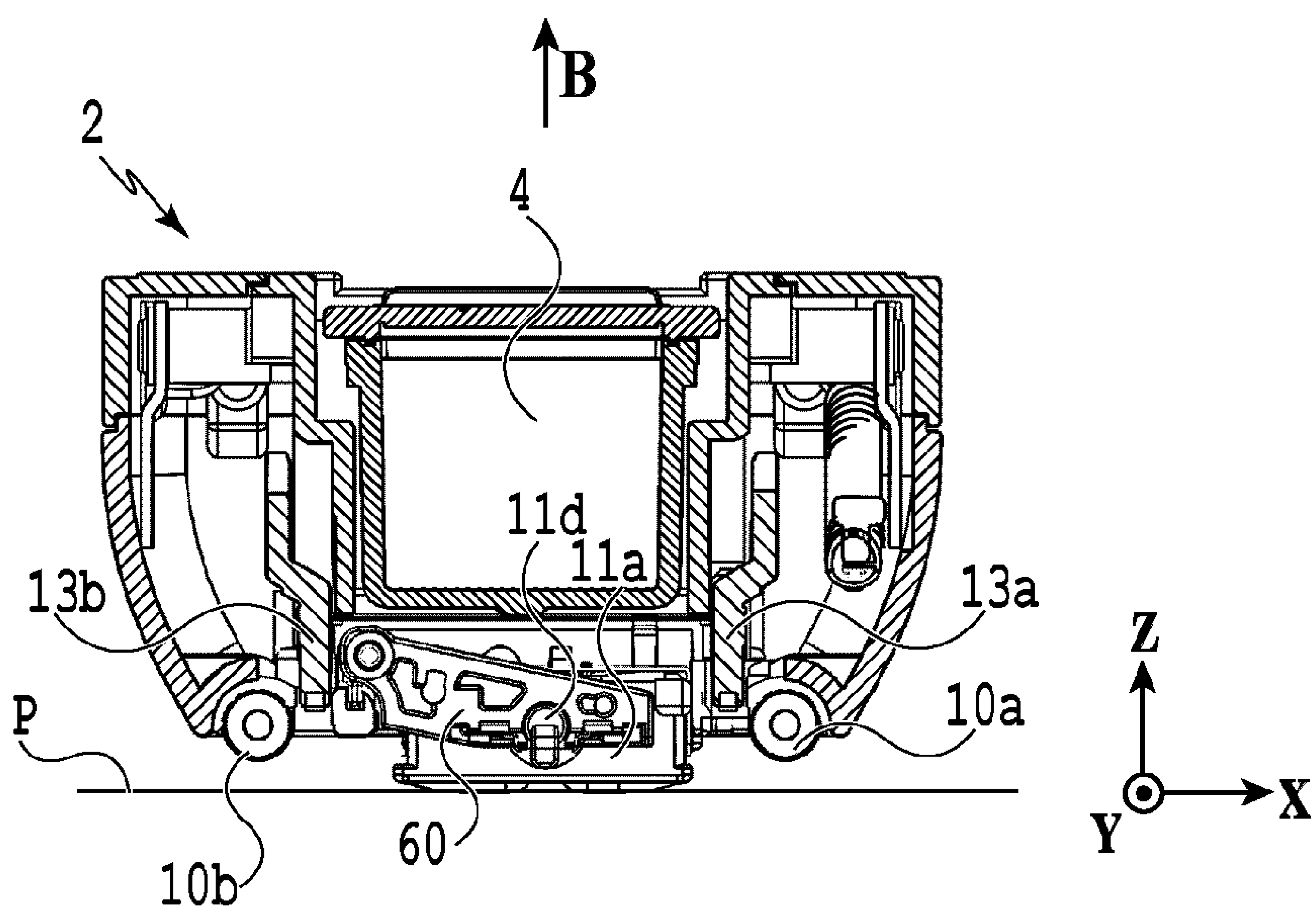

B
2
4
11d
11a
13b
13a
P
10a
10b
60
Z
X
Y

FIG.8B

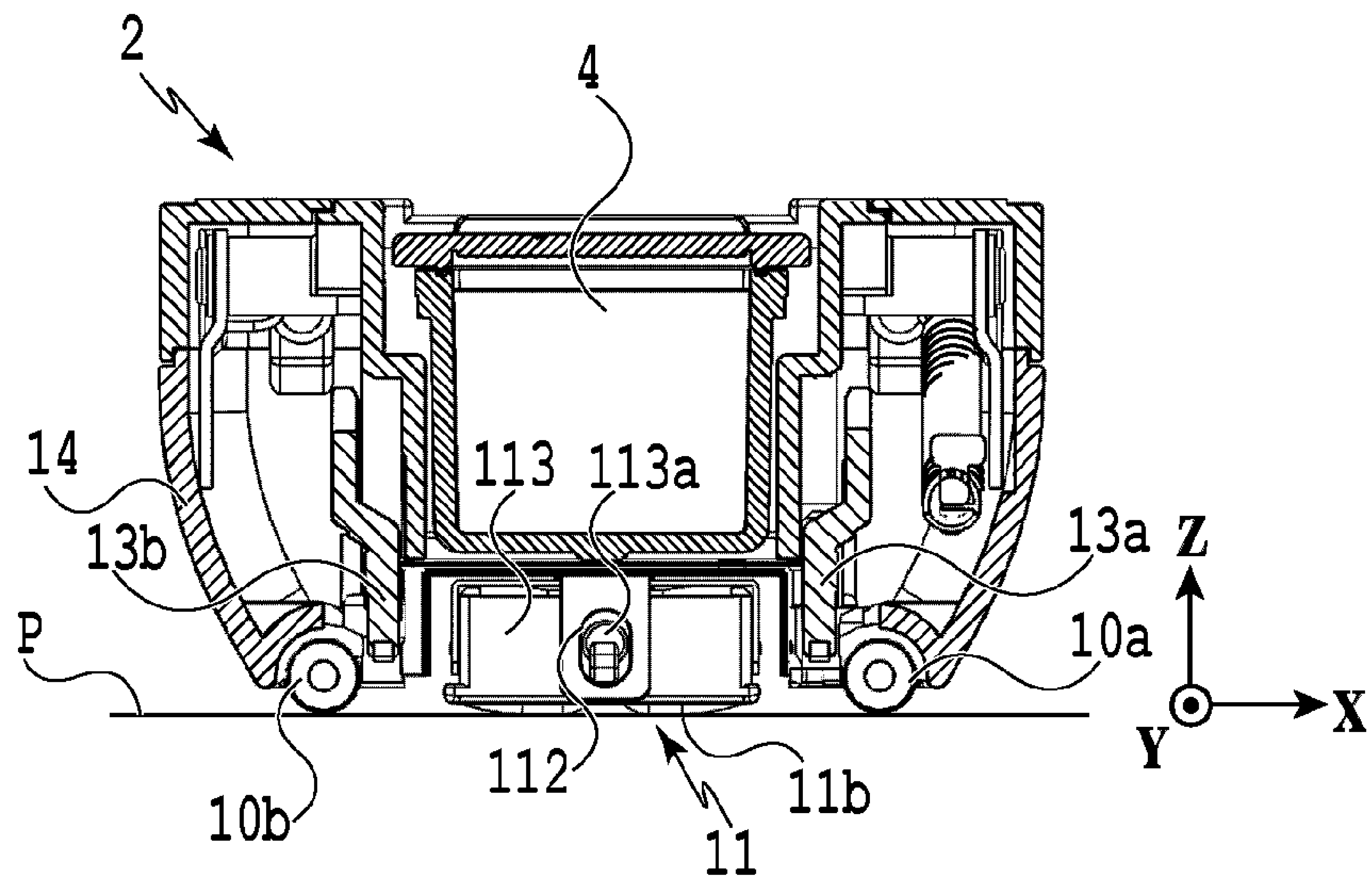


FIG.9

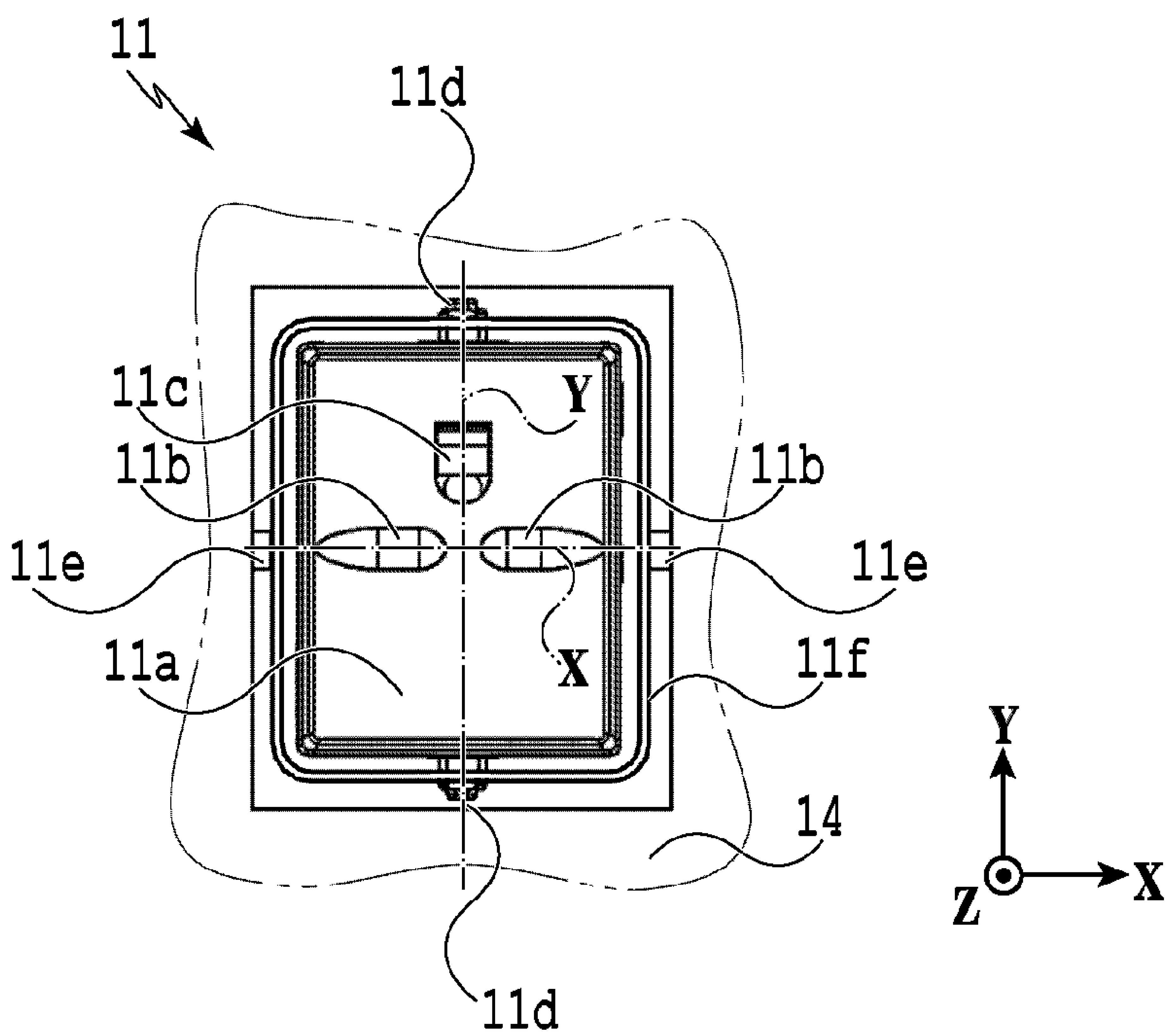


FIG.10

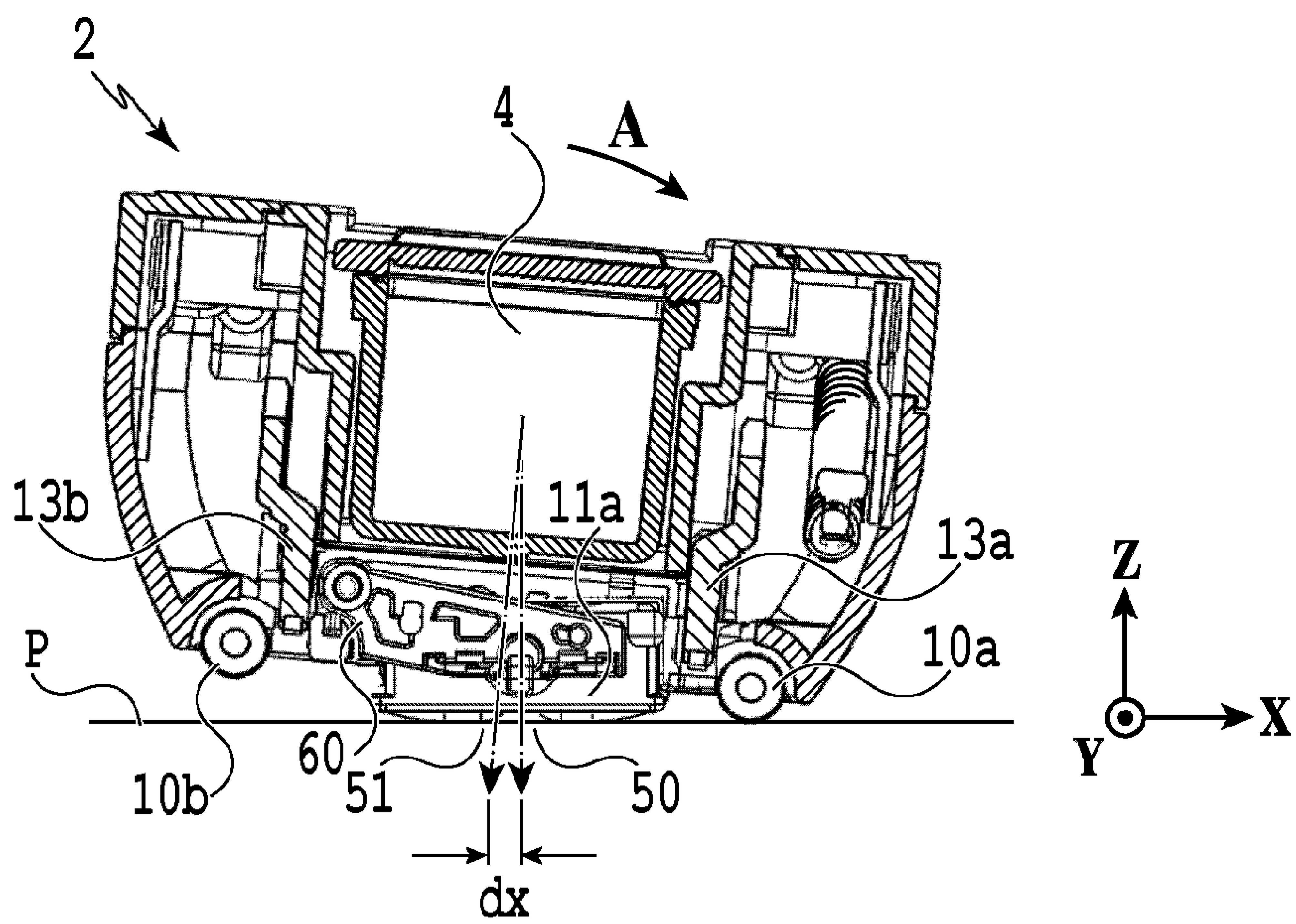


FIG.11

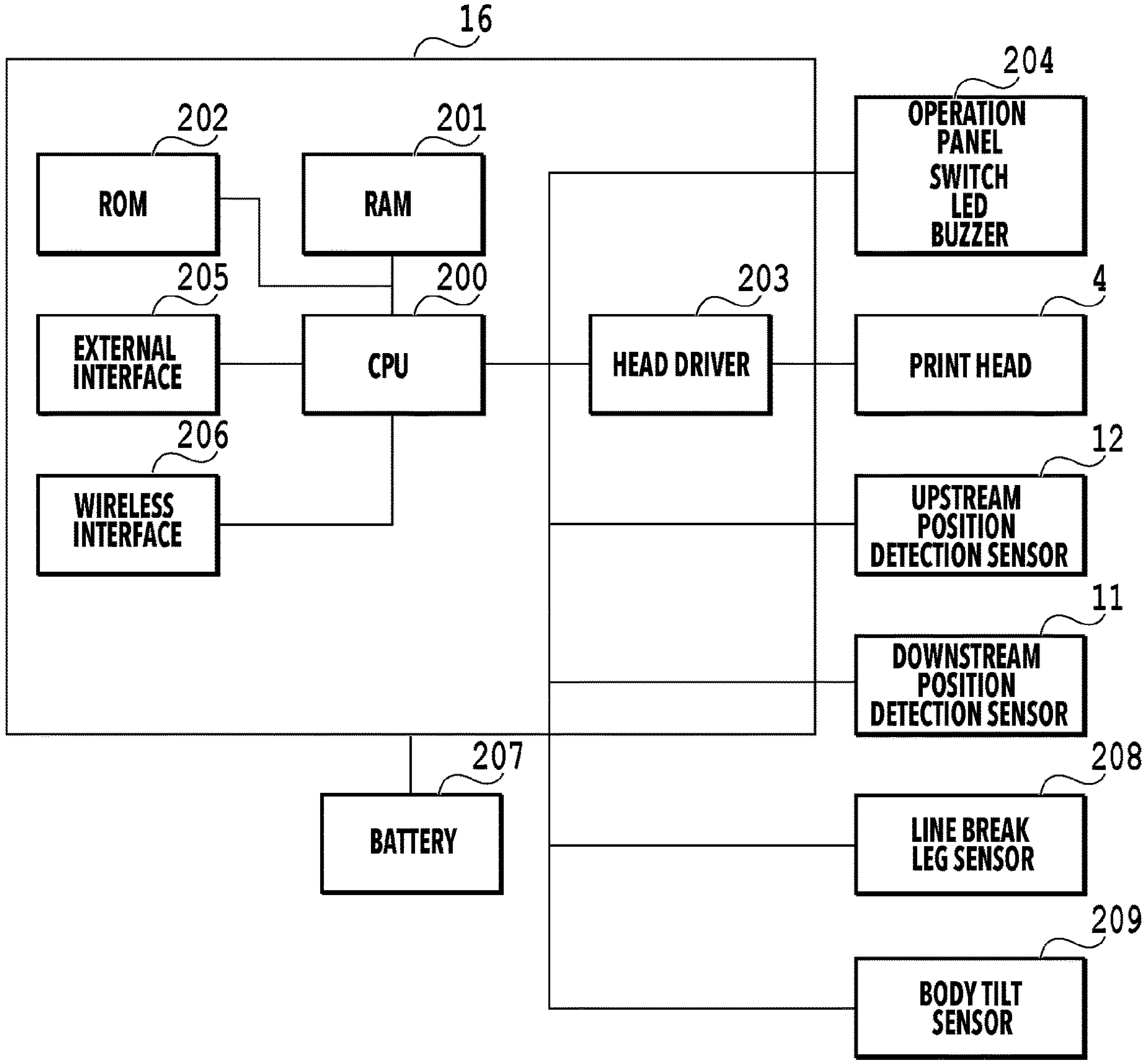

16
202
ROM
201
RAM
205
EXTERNAL INTERFACE
200
CPU
206
WIRELESS INTERFACE
203
HEAD DRIVER
204
OPERATION PANEL
SWITCH
LED
BUZZER
4
PRINT HEAD
12
UPSTREAM POSITION DETECTION SENSOR
11
DOWNSTREAM POSITION DETECTION SENSOR
207
BATTERY
208
LINE BREAK LEG SENSOR
209
BODY TILT SENSOR

FIG.12

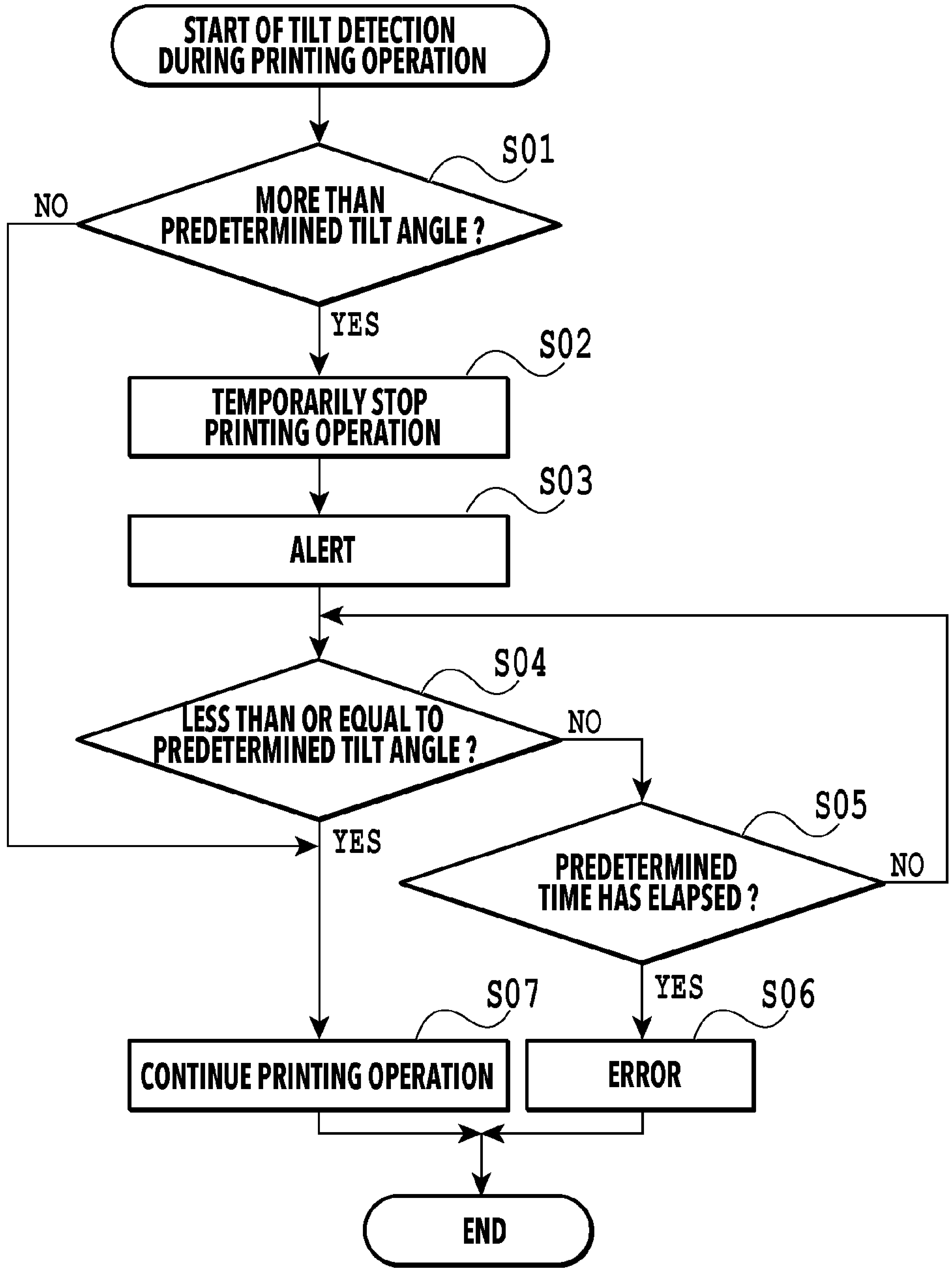

START OF TILT DETECTION DURING PRINTING OPERATION
S01
MORE THAN PREDETERMINED TILT ANGLE ?
NO
YES
S02
TEMPORARILY STOP PRINTING OPERATION
S03
ALERT
S04
LESS THAN OR EQUAL TO PREDETERMINED TILT ANGLE ?
NO
YES
S05
PREDETERMINED TIME HAS ELAPSED ?
NO
YES
S07
CONTINUE PRINTING OPERATION
S06
ERROR
END

FIG.13

HANDHELD PRINTING APPARATUS

BACKGROUND

Field of the Disclosure

The present disclosure relates to a manually scanned handheld printing apparatus for performing printing by having an operator manually scan its body.

Description of the Related Art

Japanese Patent Laid-open No. 2019-89240 discloses a handheld printer, or a manually moved printing apparatus, which detects its lift or tilt with a sensor and, if detecting any of these actions, stops ejection control of the droplet ejection device. Japanese Patent Laid-open No. 2019-89240 also discloses that the handheld printer detects its moving amount with a navigation sensor provided at a predetermined portion.

With the method of Japanese Patent Laid-open No. 2019-89240, if the manually moved printing apparatus is lifted or tilted, the ejection control is stopped and therefore the printing operation is interrupted. Moreover, the detection of the moving amount by the sensor is interrupted as well. In order to resume the printing operation after being interrupted, it is necessary to figure out the position of the printed image and the current position of the print head and then resume the printing operation such that the image printed before the interruption and the image to be printed after the resumption will be joined.

However, the interruption of the detection of the moving amount due to the lift or tilt makes it difficult to figure out the current position of the print head again. That is, it is difficult to join the image printed before the interruption and the image printed after the resumption to complete an image without deteriorating the printing quality.

SUMMARY

In view of the above, the present disclosure provides a handheld printing apparatus capable of suppressing deterioration in printing quality even if the printing apparatus is lifted or tilted.

A printing apparatus of the present disclosure is a printing apparatus comprising a holding unit configured to be held by a user to move the printing apparatus, a printing unit configured to print an image onto a print medium according to a movement of the printing apparatus, a detection unit that detects a relative moving amount between the printing apparatus and the print medium, and a shaft provided configured to support the detection unit swingably in a direction substantially orthogonal to a printing surface of the print medium to be printed.

According to the present disclosure, it is possible to provide a handheld printing apparatus capable of suppressing deterioration in printing quality even if the printing apparatus is lifted or tilted.

Further features of the present disclosure will become apparent from the following description of exemplary embodiments with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1**A is a perspective view illustrating a manually scanned handheld printing apparatus;

FIG. **1**B is a perspective view illustrating the manually scanned handheld printing apparatus;

FIG. **2**A is a view illustrating a printing operation of the printing apparatus on a print medium in a step-by-step manner;

FIG. **2**B is a view illustrating the printing operation of the printing apparatus on a print medium in a step-by-step manner;

FIG. **2**C is a view illustrating the printing operation of the printing apparatus on a print medium in a step-by-step manner;

FIG. **2**D is a view illustrating the printing operation of the printing apparatus on a print medium in a step-by-step manner;

FIG. **3** is a block diagram illustrating a configuration of a control unit in the printing apparatus;

FIG. **4**A is a view illustrating a line break mechanism in the printing apparatus along the flow of a line break operation;

FIG. **4**B is a view illustrating the line break mechanism in the printing apparatus along the flow of the line break operation;

FIG. **4**C is a view illustrating the line break mechanism in the printing apparatus along the flow of the line break operation;

FIG. **4**D is a view illustrating the line break mechanism in the printing apparatus along the flow of the line break operation;

FIG. **4**E is a view illustrating the line break mechanism in the printing apparatus along the flow of the line break operation;

FIG. **4**F is a view illustrating the line break mechanism in the printing apparatus along the flow of the line break operation;

FIG. **4**G is a view illustrating the line break mechanism in the printing apparatus along the flow of the line break operation;

FIG. **4**H is a view illustrating the line break mechanism in the printing apparatus along the flow of the line break operation;

FIG. **5**A is view illustrating a positional relationship between a printed area and the printing apparatus, and operating states of sensors;

FIG. **5**B is view illustrating the positional relationship between the printed area and the printing apparatus, and the operating states of the sensors;

FIG. **5**C is view illustrating the positional relationship between the printed area and the printing apparatus, and the operating states of the sensors;

FIG. **5**D is view illustrating the positional relationship between the printed area and the printing apparatus, and the operating states of the sensors;

FIG. **6**A is a view illustrating a downstream position detection sensor and components around it;

FIG. **6**B is a view illustrating the downstream position detection sensor and the components around it;

FIG. **7**A is a view illustrating an upstream position detection sensor and components around it;

FIG. **7**B is a view illustrating the upstream position detection sensor and the components around it;

FIG. **7**C is a view illustrating the upstream position detection sensor and the components around it;

FIG. **8**A is a view illustrating the printing apparatus in a tilted state;

FIG. **8**B is a view illustrating the printing apparatus in a lifted state;

FIG. **9** is a view illustrating a downstream position detection sensor and components around it;

FIG. **10** is a view illustrating a downstream position detection sensor;

FIG. **11** is a view illustrating a printing apparatus in a lifted state;

FIG. **12** is a block diagram illustrating a configuration of a control unit in the printing apparatus; and

FIG. **13** is a flowchart illustrating a tilt detection process during a printing operation.

DESCRIPTION OF THE EMBODIMENTS

First Embodiment

A first embodiment of the present disclosure will be described below with reference to drawings.

Note that the term "print" herein is not limited to formation of information with a meaning such as characters or a figure, and includes formation of information with a meaning and also information without a meaning. Moreover, the term is not limited by whether what is to be "printed" is elicited so as to be visually perceptible to humans, and represents a wide range of meanings such as formation of an image, a design, a pattern, or the like on a print medium and processing a print medium.

Also, the term "ink" (also referred to as "liquid") is to be widely interpreted as with the definitions of "print" mentioned above. Thus, the term represents a liquid to be used to form an image, a design, a pattern, or the like or process a print medium by being applied to a print medium, or to process an ink (e.g., solidification or insolubilization of a colorant in an ink to be applied to a print medium).

"Print medium" is mainly a medium such as a paper sheet or note, but is not particularly limited to these as long as it is a medium on which printing can be performed by attaching an ink. "Print medium" may be any material as long as it accepts an ink, such as fabric, plastic film, sheet metal, glass, ceramic, wood, or leather.

FIGS. **1**A and **1**B are perspective views illustrating a manually scanned handheld printing apparatus (hereinafter also referred to simply as "printing apparatus") **1** in the present embodiment. FIG. **1**A is a view illustrating the top side of the manually scanned handheld printing apparatus **1**, while FIG. **1**B is a view illustrating the bottom side of the manually scanned the handheld printing apparatus **1**. The printing apparatus **1** includes an upper unit **3** mainly containing a control unit's components, a lower unit **2** including a print head **4** and guide rollers **10**, and a line break handle **5** to be operated by an operator in a case of performing a line break operation. The print head **4** performs printing by ejecting an ink onto a print medium with movement of the printing apparatus **1**.

A plurality of guide rollers **10** are provided. In the present embodiment, these are a paired right guide roller **10***a* and left guide roller **10***b* which guide movement of the printing apparatus **1** in ±X directions while pressing a print medium P during a printing operation.

The lower unit **2** is provided with a downstream position detection sensor **11** and an upstream position detection sensor **12** with the print head **4** therebetween. The downstream position detection sensor **11** and the upstream position detection sensor **12** are provided to be capable of contacting the print medium. Relative to the print head **4**, the downstream position detection sensor **11** is situated on a side in the traveling direction in a line break operation after printing a single line (i.e., in the moving direction for line break), and detects the relative moving amount between the printing apparatus **1** and the print medium. The upstream position detection sensor **12** is situated on the opposite side of the print head **4** in the traveling direction in a line break operation, and detects the moving amount of the printing apparatus body. In the present embodiment, as will be described later, a line break operation of the printing apparatus **1** is an operation of moving in a +Y direction. Thus, the +Y side will be referred to as the downstream side in the traveling direction for line break (new line side), while the —Y side will be referred to as the upstream side in the moving direction for line break (previous line side).

The downstream position detection sensor **11** includes a sensor case **11***a*, sensor case sliders **11***b*, a sensor lens **11***c*, and a Y-direction sensor support shaft **11***d* (FIGS. **6**A and **6**B). The upstream position detection sensor **12** includes a sensor case **12***a*, sensor case sliders **12***b*, a sensor lens **12***c*, and a Y-direction sensor support shaft **12***d*. The lower unit **2** is further provided with line break legs **13**. The line break legs **13** are members that separate the guide rollers **10** from the print medium and move the printing apparatus body during a line break operation, and include a pair of right line break legs **13***a* and a pair of left line break legs **13***b*. During a line break operation, the two right line break legs **13***a* and the two left line break legs **13***b* contact the printing surface of the print medium.

The right guide roller **10***a* and the left guide roller **10***b* are each formed as an integrated component with one shaft **10***c* and two rollers fixed to this shaft **10***c*. The two rollers are provided coaxially with each other. The shafts **10***c* of the right guide roller **10***a* and the left guide roller **10***b* are provided substantially parallel to each other, and are supported by the lower unit case **14** so as to allow the shafts **10***c* to turn while reducing their backlashes in the thrust direction. Each roller's cylindrical surface that contacts the print medium P is preferably subjected to a process such as sticking fine abrasive grains to increase the coefficient of friction with the print medium P, and the two rollers are preferably given substantially the same diameter to achieve good straightness of travel. For the straightness of travel, it is also preferable to support the right guide roller **10***a* and the left guide roller **10***b* in parallel to each other. During movement on the print medium P, configurations as above enable the guide rollers **10** to passively roll without slipping, and also improve the straightness of travel of the printing apparatus **1**.

These mechanisms serve as a base of the lower unit **2** and housed in the lower unit case **14**, in which the print head **4**, the guide rollers **10**, and so on are disposed.

FIGS. **2**A to **2**D are views illustrating a printing operation of the printing apparatus **1** on the print medium P in a step-by-step manner. In FIGS. **2**A to **2**D, areas PA represent printed areas where images are printed. A case of printing a first single line from the left side of the print medium P toward its right side will be described below. Note that it is also possible to perform the first printing from the right side of the print medium P toward its left side.

When starting the printing, the printing apparatus is positioned at an upper left portion of the print medium P, as illustrated in FIG. **2**A. In this state, of the components of the printing apparatus **1**, the four rollers **10***a* and **10***b* of the guide rollers **10** and the sensor case sliders **11***b*, which are part of the downstream position detection sensor **11**, are in contact with the print medium P, whereas the upstream position detection sensor **12** is not in contact with the print medium P. The upstream position detection sensor **12** is not in contact with the print medium P during the printing operation in order to avoid rubbing the printed area after the later-described line break operation is performed. Thereafter, in FIG. 2B, the operator places a hand on the printing apparatus **1** and moves the printing apparatus **1** in the moving direction for printing (the direction of the arrow DX). When the printing apparatus **1** starts moving, the downstream position detection sensor **11** detects the moving amount.

In the present embodiment, while the printing apparatus **1** is moved in the moving direction for printing by the operator's operation, the downstream position detection sensor **11** is used to detect the moving amount. Also, while the printing apparatus **1** is moved in a line break direction by a line break operation by the later-described line break mechanism, the downstream position detection sensor **11** and the upstream position detection sensor **12** are used to detect the moving amount. An example of the detection of the moving amount by the two detection sensors is described below. The downstream position detection sensor **11** and the upstream position detection sensor **12** optically read characteristics of the surface of the print medium P, detect the moving amount from the movement start position, and integrate this moving amount to thereby calculate the current position of the printing apparatus **1**.

In the present embodiment, sensors of types capable of accurately detecting moving amount are used, and the working distance between the sensors and the print medium P needs to be 2.4 mm with the distance tolerance range kept within ±0.3 mm. A printing operation is performed by detecting the relative moving amount between the printing apparatus **1** and the print medium P with sensors as above and ejecting the ink from the print head **4** according to the moving amount of the printing apparatus **1**. Note that the detection method of the downstream position detection sensor **11** and the upstream position detection sensor **12** is not limited to the above method, and may be any method as long as it can detect the relative positions of the printing apparatus **1** and the print medium P.

Now, a configuration of a control unit **16** in the printing apparatus **1** will be described. FIG. **3** is a block diagram illustrating a configuration of the control unit **16** in the printing apparatus **1**. The control unit **16** includes a CPU **200**, a RAM **201**, a ROM **202**, a head driver **203**, an external interface **205**, and a wireless interface **206**. Moreover, the control unit **16** is connected to an operation panel **204**, the print head **4**, the upstream position detection sensor **12**, the downstream position detection sensor **11**, a battery **207**, and a line break leg sensor **208**. The CPU **200** is responsible for performing data processing, obtaining sensor information, and controlling the driving of the print head. The RAM **201** is responsible for temporarily storing programs and image data to be printed and the like. The ROM **202** stores programs and various setting values. The head driver **203** is responsible for control for ejecting the ink from the nozzles in the print head **4**.

The operation panel **204** is provided in the printing apparatus **1** and includes various switches, a display unit such as an LED display, a buzzer, and so on. The external interface **205** is responsible for data exchange with an external control apparatus and the like. The wireless interface **206** wirelessly controls the printing apparatus **1** in place of the external interface **205**. The battery **207** is used to drive the printing apparatus **1** in a cordless manner. The line break leg sensor **208** detects the operation of the line break legs **13** to be described later. The ink ejection of the print head **4** is controlled by these components of the control unit **16**. Specifically, before the start of a printing operation, at least print data necessary for printing a single line is received via the wireless interface **206** or the external interface **205**, and this print data is stored in the RAM **201**. After various print settings are determined and the printing operation becomes ready to be started, the operator is notified via the operation panel **204** that the printing operation can be started.

The print head **4** employs an inkjet method by which it ejects the ink from a plurality of minute nozzles arranged substantially straight in a direction crossing the moving direction for printing. Thus, an image is formed by reading data out of the RAM **201** according to the result of the moving amount detection by the downstream position detection sensor **11** and causing the CPU **200** to determine the timing and the data to be printed at the corresponding position, and ejecting the ink from the print head **4** as appropriate. At this time, the printing apparatus **1** is manually scanned by the operator. The moving speed is therefore not guaranteed to be constant, and the speed is expected to vary. Control is performed such that the image will be printed as indicated by the original data on the print medium P even with such speed variation. By continuously performing this process, the operation of printing a single line is completed. After the completion of the single-line printing operation, the operator looks at the image or is notified of the completion of the single-line printing operation via the operation panel **204**, and stops the scanning operation in the moving direction for printing DX.

In FIG. **2**C, a line break operation is performed by the operator's operation. The line break operation is an operation performed for the purpose of applying an effect equivalent to a so-called line feed operation involving conveying a sheet by a predetermined distance after a single-line printing operation of the carriage in a general serial scan-type printer. Specifically, the line break operation is an operation of moving the print head **4** in the moving direction for line break (the direction of the arrow DY), which is substantially orthogonal to the moving direction for printing (the direction of the arrow DX), to a position from which to perform the next single-line printing operation according to the position, on the print medium P, of a printed area PA**1** completed by the single-line printing operation.

While details of the line break operation will be described later, the operator's operation involves moving the line break handle **5** in a lever operating direction for line break (the direction of the arrow ML). In conjunction with the line break operation triggered by this operator's operation, the line break legs **13** act so as to move the printing apparatus **1** a predetermined distance in the moving direction for line break (the direction of the arrow DY). Note that the printing apparatus **1** includes a mechanism that brings not only the downstream position detection sensor **11** but also the upstream position detection sensor **12** into contact with the print medium P during a line break movement. The moving amount of the printing apparatus **1** may vary, and the printing apparatus **1** may rotate in the plane of the print medium P (in the direction of the arrow R in FIG. **2**C) before or after the line break movement. In this case, by detecting the state of the line break movement of the printing apparatus **1** with the plurality of position detection sensors, it is possible to detect the amounts of the variation and the rotation. Note that the upstream position detection sensor **12** is configured to be separated from the print medium P again when the line break movement is finished. The line break operation is now completed.

Thereafter, in FIG. **2**D, a printing operation is performed for the second line. The printing operation of the second line is prepared by preparing image data by a process similar to that for the printing operation of the first line and, if the moving amount varied during the line break operation, correcting the variation. The operator performs a basic operation similar to that for the first line. Here, by preparing print data during the line break operation, the printing operation will be basically ready to be performed after the line break operation. In this way, the operator can immediately start the second scan. Since the scanning direction for the second line is the reverse of the scanning direction for the first line, the operator moves the printing apparatus **1** in the direction of the arrow −DX.

The image of the second line is formed in a similar manner to the scan for the first line by detecting the moving amount with the downstream position detection sensor **11** and ejecting the ink from the print head **4** according to the position. By performing appropriate correction, images can be formed in a unified manner in the printed area PA**1** of the first line and a printed area PA**2** of the second line with almost no misalignment. Note that description of the method of the correction is omitted since it is not the subject matter of the present embodiment. If necessary, the operator continuously performs a printing operation in a similar manner for the third line, the fourth line, and so on to complete forming the desired image.

FIGS. **4**A to **4**H are views illustrating the line break mechanism in the printing apparatus **1** along the flow of a line break operation. The line break mechanism in the printing apparatus **1** includes a line break lever **50**, a line break mechanism drive gear train **51**, a drive gear train reset lever **52**, a drive gear train reset sub lever **53**, and a drive gear train reset cam **54**. The line break lever **50** operates in conjunction with the line break handle **5**. The line break mechanism drive gear train **51** is driven in response to the operation of the line break lever **50**, and causes the line break legs **13** to operate. The line break legs **13** are rotationally moved in the clockwise direction in FIGS. **4**A to **4**H by the line break mechanism drive gear train **51**. When the line break legs **13** come into contact with the print medium P, the line break legs **13** serve as fixed base points on the print medium P, about which the printing apparatus **1** rotationally moves in the clockwise direction in FIGS. **4**A to **4**H.

The drive gear train reset lever **52** brings the line break mechanism drive gear train **51** back to its initial state. The drive gear train reset sub lever **53** operates in the last half of the operation of bringing the line break mechanism drive gear train **51** back to its initial state. The drive gear train reset cam **54** receives force from the drive gear train reset lever **52** and the drive gear train reset sub lever **53**. The drive gear train reset cam **54**, which is on the line break mechanism drive gear train **51**, is provided integrally with one of the gears of the line break mechanism drive gear train **51**, and rotates in the counterclockwise direction in FIGS. **4**A to **4**H in response to the operation on the line break lever **50**. Also, gears coupled to both sides of both sides of a gear integrally provided to the drive gear train reset cam **54** rotate in the clockwise direction in FIGS. **4**A to **4**H in response to the operation of the line break lever **50**. The line break legs **13** make the clockwise rotational movement in synchronization with this rotation.

FIG. **4**A illustrates a normal standby state and a printing operation state before entering a line break operation. The line break handle **5** is stopped at its initial position in a state of being biased by a spring not illustrated. The guide rollers **10** are in contact with the print medium P and supported by bearings not illustrated which are provided in the lower unit case **14**. Hence, the height to the printing apparatus **1** is determined by the guide rollers **10**. The downstream position detection sensor **11** is constantly pressed in such a direction as to contact the print medium P, thereby being ready to measure the moving amount. The upstream position detection sensor **12** has retracted to a retracted position in conjunction with the line break mechanism drive gear train **51**, thereby not being in contact with the print medium P. The line break legs **13** are in a standby state at their initial positions inside the printing apparatus **1**, being not in contact with the print medium P.

FIG. **4**B illustrates a state where the operator starts pulling the line break handle **5** in the +Y direction in FIG. **4**B, thereby starting a line break operation. In response to the start of the line break operation, firstly, a lock member (arm drive lever A **63** in FIG. **7**A) which has retracted the upstream position detection sensor **12** moves in a −Z direction. As a result, the upstream position detection sensor **12** becomes movable in the ±Z directions (up-down direction), and also pressed by a pressing spring not illustrated in the −Z direction into contact with the print medium P. Thereafter, in FIG. **4**C, the operator moves the line break handle **5** farther in the +Y direction. This causes the line break mechanism drive gear train **51** to act so as to move the line break legs **13** in the −Z direction into contact with the print medium P.

Next, in FIG. **4**D, the line break handle **5** is moved farther in the +Y direction by the operator's operation. As a result, the line break legs **13** project farther than the guide rollers **10** in the −Z direction. This causes the printing apparatus **1** to start moving in the +Z direction. The line break legs **13** themselves make a transitional movement having a rotational locus inside the printing apparatus **1** in conjunction with gears of the line break mechanism drive gear train **51**. Since the tips of the line break legs **13**, which are made of a slip resistance material, are in contact with the print medium P, the body of the printing apparatus **1** conversely starts moving in the +Z direction with a transitional movement having a rotational locus.

Specifically, the body of the printing apparatus **1** moves in the direction of the arrow A in FIG. **4**D. FIG. **4**D illustrates a state where the printing apparatus **1** has reached a half of the moving amount for the line break operation. This is a state where the printing apparatus **1** has moved a distance L**1** in the moving direction for line break (+Y direction) from its position before the start of the line break (the white triangle mark in FIG. **4**D). It can be observed that the height from the print medium P to the body of the printing apparatus **1** was H**1** at the point of FIG. **4**C but the height to the body of the printing apparatus **1** has increased to H**2** in FIG. **4**D. As the body of the printing apparatus **1** gets separated from the print medium P, the guide rollers **10** get separated from the print medium P as well. This enables the printing apparatus **1** to move forward in a direction other than the moving direction in the printing operation. As the line break mechanism drive gear train **51** further rotates from the state of FIG. **4**D, the printing apparatus **1** starts moving in the −Z direction. During this time too, the upstream position detection sensor **12** keeps receiving a pressing force from the pressing spring. Thus, not only the downstream position detection sensor **11** but also the upstream position detection sensor **12** remains in contact with the print medium P.

Next, in FIG. **4**E, the line break handle **5** is moved farther in the +Y direction by the operator's operation and reaches a predetermined position. As a result, the guide rollers **10** contact the print medium P, and the line break legs **13** are contained in the printing apparatus **1**. With the guide rollers **10** contacting the print medium P, the guide rollers **10** act such that the printing apparatus **1** stops moving in the line break direction (+Y direction). The printing apparatus **1** has now completed moving a moving amount L2 determined in advance by the configuration of the line break mechanism drive gear train **51**. Thereafter, in FIG. **4**F, the line break handle **5** is returned to its initial position illustrated in FIG. **4**A by the action of the spring not illustrated. Note that the above does not apply if the operator keeps holding the line break handle **5**. Incidentally, the line break lever **50** and the line break mechanism drive gear train **51** are coupled via a one-way clutch not illustrated. Thus, the line break mechanism drive gear train **51** shifts to the next operation regardless of the position of the line break lever **50**.

The drive gear train reset cam **54** on the line break mechanism drive gear train **51** is at such an angular phase as to receive a force from the drive gear train reset lever **52** and the drive gear train reset sub lever **53**, which are spring-biased. Thus, due to the force from the drive gear train reset lever **52** and the drive gear train reset sub lever **53**, the drive gear train reset cam **54** is subjected to a rotational force in the counterclockwise direction in FIGS. **4**A to **4**H. The line break mechanism drive gear train **51** keeps operating for as long as this rotational force acts on the drive gear train cam **54**. Also, immediately after reaching the state of FIG. **4**F, the lock member not illustrated in FIGS. **4**A to **4**H (the arm drive lever A **63** in FIG. **7**A) rises, so that the upstream position detection sensor **12** starts moving in the +Z direction toward the retracted position.

FIG. **4**G illustrates a next state where the line break legs **13** have moved to the farthest position from the print medium P in the course of the resetting operation of the line break mechanism drive gear train **51**. In this state, the upstream position detection sensor **12** has moved to the retracted position and is completely separated from the print medium P. FIG. **4**H illustrates a subsequent state where the force from the drive gear train reset lever **52** and the drive gear train reset sub lever **53** no longer acts on the drive gear train reset cam **54** and the line break mechanism drive gear train **51** has stopped rotating, so that components have returned to their initial positions. Specifically, the upstream position detection sensor **12** and the line break legs **13** have returned to the same states as their states in FIG. **4**A.

Line break is performed by such a series of operations. It can be observed that the printing apparatus **1** is actually moved in the period from FIG. **4**C to FIG. **4**E, as described above. In this period, the height from the print medium P to the body of the printing apparatus **1** increases from the height H**1** to the height H**2** but the downstream position detection sensor **11** and the upstream position detection sensor **12** remain in contact with the print medium P. Thus, during a line break operation, the moving amount of the printing apparatus **1** is detected by the two sensors, the downstream position detection sensor **11** and the upstream position detection sensor **12**.

FIGS. **5**A to **5**D are views schematically illustrating the positional relationship between a printed area PA and the printing apparatus **1** and the operating state of each sensor in printing operations including line break operations. In FIGS. **5**A to **5**D, each black rectangle represents a state where the upstream position detection sensor **12** or the downstream position detection sensor **11** is in contact with the print medium P, while each white rectangle represents a state where the upstream position detection sensor **12** or the downstream position detection sensor **11** is not in contact with the print medium P. FIG. **5**A illustrates a state where a line break operation has been performed after an operation of printing the first line from the right side of FIG. **5**A to its left side, and an operation of printing the second line is being performed from the left side toward the right side. In this state, the downstream position detection sensor **11** is in contact with the print medium P while the upstream position detection sensor **12** is not in contact with the print medium P.

FIG. **5**B illustrates a state where the printing operation of the second line has been finished, and a line break operation has started. Basically, the line break operation is performed from a position separated from the printed area PA. Specifically, after completing the printing of the second line, the operator continues moving the printing apparatus **1** farther and performs the line break operation from a position separated from the printed area PA. During the line break operation, the downstream position detection sensor **11** is in contact with the print medium P and the upstream position detection sensor **12** is also in contact with the print medium P. By performing the line break operation from a position separated from the printed area PA as described above, the line break operation can be performed without the upstream position detection sensor **12** rubbed on the printed area PA.

FIG. **5**C illustrates a state where the line break operation has been finished. In this state, the downstream position detection sensor **11** is in contact with the print medium P while the upstream position detection sensor **12** is not in contact with the print medium P. FIG. **5**D illustrates a state where an operation of printing the third line is being performed from the right side toward the left side. In this state, the downstream position detection sensor **11** is in contact with the print medium P while the upstream position detection sensor **12** is not in contact with the print medium P. Since the upstream position detection sensor **12** is not in contact with the print medium P, the upstream position detection sensor **12** is not rubbed on the printed area PA during the printing operation.

As has been described above, the upstream position detection sensor **12** switches back and forth between a contact state and a non-contact state. Hence, a trigger for determining the timing to start a position detecting operation is needed. For this reason, in the present embodiment, the line break leg sensor **208** (see FIG. **3**) is used. The line break leg sensor **208** is a sensor that detects the position of the upstream position detection sensor **12**, and detects whether the upstream position detection sensor **12** is in the raised position or the lowered position. The upstream position detection sensor **12** is caused to start a reading operation in a case where the line break leg sensor **208** detects that the upstream position detection sensor **12** is lowered, and is caused to finish the reading operation in a case where the line break leg sensor **208** detects that the upstream position detection sensor **12** is raised.

FIGS. **6**A and **6**B are views illustrating the downstream position detection sensor **11** and components around it. FIGS. **6**A and **6**B are views of the downstream position detection sensor **11** as seen from the position indicated by the line VI-VI of FIG. **4**A. FIG. **6**A illustrates a normal standby state and a printing operation state before the printing apparatus **1** enters a line break operation. The downstream position detection sensor **11** in the present embodiment is configured to be movable relative to the guide rollers **10** in the +Z direction, which is substantially orthogonal to the printing surface of the print medium. The downstream position detection sensor **11** is constantly biased toward the print medium P. In the state of FIG. **6**A, the downstream position detection sensor **11** and the print medium P are in contact with each other. The guide rollers **10** are also in contact with the print medium P. FIG. **6**B is a cross-sectional view illustrating the operating state illustrated in FIG. **4**D, which is a state in the middle of a line break operation. In FIGS. **6**A and **6**B, only the lower unit **2** is illustrated, and a cross section of the upper unit **3** is omitted.

The Y-direction sensor support shaft **11***d* is formed integrally with the downstream position detection sensor case **11***a* and extends in the Y direction. A downstream sensor case support arm **60** is rotatably engaged with the Y-direction sensor support shaft **11***d* and is rotatably supported as a link that rotates about a support arm shaft **61** fixed to the lower unit case **14**. In the state of FIG. **6**A, the guide rollers **10** are in contact with the print medium P and at the same time the downstream position detection sensor **11** is in contact with the print medium P, as mentioned above. The downstream position detection sensor **11** is brought into contact with the print medium P as a result of the downstream sensor case support arm **60** being biased by a spring not illustrated with a moment in the clockwise direction in FIG. **6**A about the support arm shaft **61**.

The downstream sensor case support arm **60** presses the Y-direction sensor support shaft **11***d* in the −Z direction, and the two sensor case sliders **11***b*, which are disposed bilaterally symmetrically about the Y-direction sensor support shaft **11***d*, are brought into contact with the print medium P. As a result, the downstream position detection sensor case **11***a* is equalized along the print medium P and brought into stable contact with it. For the sensor case sliders **11***b*, it is preferable to use a material with a low coefficient of friction with the print medium P. Doing so can reduce the sliding friction between the print medium P and the sensor case sliders **11***b* during printing operations and line break operations.

Also, the bearing portion of the support arm shaft **61** and the downstream sensor case support arm **60** and the bearing portion of the downstream sensor case support arm **60** and the Y-direction sensor support shaft **11***d* are each preferably configured with as small play as possible. Configurations with small play can prevent a change in the relative positions of the lower unit case **14** and the downstream position detection sensor case **11***a* and vibration of the downstream position detection sensor case **11***a* when the sensor case sliders **11***b* receive a frictional force. Moreover, the downstream position detection sensor case **11***a* and the downstream sensor case support arm **60** have a spring installed on one side of a support portion of the downstream position detection sensor case **11***a* so as to bias the downstream position detection sensor case **11***a* in one of the ±Y directions. This configuration can prevent a change in the relative position of the downstream position detection sensor case **11***a* in the line break direction and vibration of the downstream position detection sensor case **11***a*.

Owing to such a support configuration of the downstream position detection sensor **11**, the downstream position detection sensor case **11***a* is stably pressed against the print medium P. Accordingly, the distance between the sensor lens **11***c* and the downstream position detection sensor **11**, which are fixed inside the downstream position detection sensor case **11***a*, and the print medium P can be maintained constant. Moreover, the distance between the downstream position detection sensor **11** and the print medium P can be accurately maintained since the accuracy of the distance is determined by the dimensional accuracy of a single component, the downstream position detection sensor case **11***a*.

The downstream position detection sensor case **11***a* is usually a part produced by resin molding with a mold. Accordingly, the part's dimensional reproducibility is high. This makes it possible to significantly reduce variation between products. Further, as illustrated in FIG. **1**B, the sensor case sliders **11***b* are positioned very close to the sensor lens **11***c*. Thus, even if the print medium P is deformed, the sensor case sliders **11***b* hold down the deformed portion. Hence, the downstream position detection sensor **11** is hardly affected by the deformation of the print medium P and can stably detect the moving amount.

During a line break operation, as illustrated in FIG. **6**B, the line break legs **13** project from a lower portion of the lower unit case **14** and come into contact with the print medium P, so that the body of the printing apparatus **1** moves in the +Z direction. At this time, the downstream sensor case support arm **60**, which is biased in the −Z direction by the spring not illustrated, rotates clockwise and keeps biasing the downstream position detection sensor case **11***a* toward the print medium P. This makes it possible to continue detecting the moving amount of the printing apparatus **1** even during the line break operation.

In the present embodiment, the movement of the downstream position detection sensor **11** involves a rotational movement via a swinging movement of the downstream sensor case support arm **60**. This means that the downstream position detection sensor **11** is slightly displaced in the ±X directions as viewed from the lower unit case **14**. Nonetheless, the slight displacement in the ±X directions is not problematic since it is only necessary to compare the position in the Y direction in the state of FIG. **4**C and that in the state of FIG. **4**E in order to determine the moving distances and moving directions before and after a line break operation.

The configuration of the downstream position detection sensor **11** described above is the same as the upstream position detection sensor **12**. Thus, the above statement also applies to the upstream position detection sensor **12**.

Next, a reason for retracting the upstream position detection sensor **12** to separate it from the print medium P during periods other than while line break operations are performed in the present embodiment will be described. As has been described above, detecting the position of the printing apparatus **1** requires the sensor case sliders **11***b* and **12***b* (see FIG. **1**B) and the print medium P to be rubbed against each other. As can be analogized from the explanatory views of FIGS. **2**C and **2**D, if the upstream position detection sensor **12** is brought into contact with the print medium P during the printing of the second line in FIG. **2**D or of a subsequent line, the sensor case sliders **12***b* get rubbed on the printed area PA. If there is an ink yet to be fixed in the rubbed region, the sensor case sliders **12***b* spread this ink over the print medium P, which results in unintended soiling. This deteriorates the image quality and must be avoided.

For this reason, in the present embodiment, the upstream position detection sensor **12** is separated from the print medium P during printing operations. During line break operations, which are performed outside the printed area PA, rubbing the upstream position detection sensor **12** does not cause soiling. The upstream position detection sensor **12** is therefore brought into contact with the print medium P, and the position of the printing apparatus **1** is detected with the two sensors, the downstream position detection sensor **11** and the upstream position detection sensor **12**. This enables accurate measurement of the moving amount of the printing apparatus **1**.

FIGS. **7**A to **7**C are views illustrating the upstream position detection sensor **12** and components around it. FIGS. **7**A to **7**C are views of the upstream position detection sensor **12** as seen from the position indicated by the line VII-VII of FIG. **4**A. FIG. **7**A illustrates a normal standby state and a printing operation state before the printing apparatus **1** enters a line break operation. The upstream position detection sensor **12** in the present embodiment is configured to be movable relative to the guide rollers **10** in the ±Z directions, like the downstream position detection sensor **11**.

The upstream position detection sensor **12** is configured to be capable of being moved by a moving mechanism between the retracted position and the contact position in conjunction with the line break mechanism drive gear train **51**. The moving mechanism includes an upstream sensor case support arm **62**, the arm drive lever A **63**, and an arm drive lever B **64**. Like the downstream sensor case support arm **60** (see FIGS. **6**A and **6**B), the upstream sensor case support arm **62** supports the upstream position detection sensor case **12***a*. The arm drive lever A **63** is used to drive the upstream sensor case support arm **62**. The arm drive lever B **64** is a member linking the arm drive lever A **63** and the upstream sensor case support arm **62**.

In the state of FIG. **7**A, the upstream position detection sensor **12** has retracted to the retracted position in conjunction with the line break mechanism drive gear train **51** and is not in contact with the print medium P. The upstream position detection sensor **12** is basically configured to be moved in the ±Z directions by the moving mechanism in conjunction with the line break mechanism drive gear train **51**. The upstream position detection sensor **12** is brought into contact with the print medium P only during line break operations. During other periods, the upstream position detection sensor **12** is separated from the print medium P and retracted to the retracted position inside the body of the printing apparatus **1**.

During printing operations, during which the upstream position detection sensor **12** is located at the retracted position, and in a state immediately before starting a line break operation (the state of FIG. **7**A), a spring not illustrated acts on the arm drive lever A **63** such that the arm drive lever A **63** is biased in the +Z direction and brought into contact with and stopped by a stopper not illustrated. The arm drive lever A **63** includes a protrusion **63***a*. The arm drive lever A **63** is engaged with the upstream sensor case support arm **62** via the arm drive lever B **64** fitted to the protrusion **63***a* through a hole therein. The upstream sensor case support arm **62** includes a support arm protrusion **62***a*, which is pulled up in the +Z direction by the arm drive lever B **64**, thereby retracting the upstream position detection sensor **12** to the retracted position inside the printing apparatus **1**.

As the line break handle **5** is moved by the operator's operation and a line break operation starts, the cam on the line break mechanism drive gear train **51** acts so as to press the arm drive lever A **63** such that the state of FIG. **7**B is reached from the state of FIG. **7**A. Specifically, the protrusion **63***a* of the arm drive lever A **63** moves in the −Z direction, so that the arm drive lever B **64** moves in the −Z direction as well. This releases the support arm protrusion **62***a* from a constrained state, so that the upstream sensor case support arm **62** rotates about the support arm shaft **61** in the clockwise direction in FIGS. **7**A to **7**C. Thus, the upstream position detection sensor **12** also contacts the print medium P, as illustrated in FIG. **7**B. The protrusion **63***a* of the arm drive lever A **63** and the hole of the arm drive lever B **64** are fitted to each other with a large backlash therebetween. Accordingly, in the state where the arm drive lever A **63** is lowered, the upstream position detection sensor **12** is freely movable in the up-down direction within a predetermined range. The movement in this state is similar to that of the downstream position detection sensor **11** described with reference to FIGS. **6**A and **6**B. FIG. **7**C is a view of a state corresponding to FIG. **4**D. The rollers **10***a*, **10***b* have been separated from the print medium P but the upstream position detection sensor **12** remains in contact with the print medium P.

FIGS. **8**A and **8**B are cross-sectional views of the downstream position detection sensor **11** as seen from the position indicated by the line VI-VI of FIG. **4**A, illustrating the printing apparatus **1** tilted in the middle of the operator's operation and the printing apparatus **1** lifted in the middle of the operator's operation. Note that the upper unit **3** is omitted in the illustrations of FIGS. **8**A and **8**B. In the following, a description will be given of the operation of the downstream position detection sensor **11** in a case where the printing apparatus **1** is tilted and in a case where the printing apparatus **1** is lifted. FIG. **8**A is a cross-sectional view as seen from the line VI-VI of FIG. **4**A, illustrating a state where the printing apparatus **1** is tilted about the right guide roller **10***a* by approximately 5° in the direction of the arrow A. FIG. **8**B is a cross-sectional view as seen from the line VI-VI of FIG. **4**A, illustrating a state where the printing apparatus **1** is lifted by approximately 5 mm in the direction of the arrow B.

The state of FIG. **8**A occurs mainly when the printing apparatus **1** is scanned during a printing operation. This tends to occur in a case where the operator puts too much muscle with the operator's hand when grasping and moving the printing apparatus **1** in the direction of the arrow DX or −DX as illustrated in FIG. **2**B. There are three factors described below that cause such a tilt of the printing apparatus **1**.

The first factors is the operator applying a force to the printing apparatus **1** for scanning it. Specifically, during a printing operation, the operator applies a force to the printing apparatus **1** in the direction of one of the arrows DA, which is a scanning direction (see FIG. **1**B). If the operator applies such a force as to exert a moment on the printing apparatus **1**, the body of the printing apparatus **1** may get tilted about a rotation axis extending in the direction of the arrows DB (see FIG. **1**B), which is substantially orthogonal to the scanning direction (the direction of the one arrow DA).

The second factor lies in an action of one guide roller **10**. In a static state like FIG. **2**A, the right guide roller **10***a* and the left guide roller **10***b* are both in contact with the print medium P. Here, there is a case where the print medium P has a small bump or dent, for example. Then, as the operator moves the printing apparatus **1** as illustrated in FIG. **2**B to start a printing operation, the guide roller **10** on the side in the travelling direction may get caught on the bump or dent, thereby hampering the travel of the printing apparatus **1**. Moreover, since the operator grips an upper part of the printing apparatus **1** (upper unit **3**), the above hampering of the travel results in application of a moment to the printing apparatus **1**, which may tilt the printing apparatus **1** in the travelling direction about the shaft of the guide roller **10** as a rotation axis.

The third factor lies in the shape of the surface of the printing apparatus **1** facing the print medium P, i.e., the shape of the bottom surface of the printing apparatus **1** illustrated in FIG. **1**B. The printing apparatus **1** is configured such that the distance between the print head **4** and each guide roller **10** in the scanning direction (the direction of the arrows DA in FIG. **1**B) is minimized in order to widen the printable range on the print medium P. On the other hand, the two rollers **10***a* being the wheels of the guide roller **10** are disposed with a relatively wide gap therebetween in order to ensure straightness of travel of the printing apparatus **1** in the scanning direction.

For this reason, the bottom surface of the printing apparatus **1** has a shape that is relatively wide in the direction of the gap between the two rollers **10***a* of each guide roller **10** and relatively narrow in the direction of the gap between the two guide rollers **10**. As a result, the shape of the bottom surface has an aspect ratio as illustrated in FIG. **1**B, which makes the body of the printing apparatus **1** somewhat unstable in the direction in which the width is narrow (scanning direction). Accordingly, the printing apparatus **1** may get tilted about the shaft of one of the guide rollers **10** as a rotation axis. In order to continue the detection of the position of the printing apparatus **1** with the downstream position detection sensor **11** even after the printing apparatus **1** gets tilted by any of the three factors described above, it is desirable to support the downstream position detection sensor case **11***a* so as to follow the printing surface of the print medium P.

Thus, in order to continue the detection of the position of the printing apparatus **1** even in a case where it gets tilted, the downstream position detection sensor case **11***a* in the present embodiment is swingably supported about an axis extending in a direction substantially parallel to the printing surface of the print medium to be printed and substantially orthogonal to the scanning direction for printing. Specifically, as described earlier and illustrated in FIG. **8**A, the Y-direction sensor support shaft **11***d* formed integrally with the downstream position detection sensor case **11***a* and having a rotation axis extending in the direction of the arrows DF (see FIG. **1**B) is configured to be rotatably supported by the downstream sensor case support arm **60**. With this configuration, even if the body of the printing apparatus **1** gets tilted by the operator's operation in the middle of a printing operation, the downstream position detection sensor **11** can rotate so as to follow the print medium P and continue the position detection.

The state of FIG. **8**B is not likely to occur unless the operator handles the printing apparatus **1** in such a manner as to lift it up in the middle of a printing operation. Nonetheless, even if the operator performs such an operation by mistake, the downstream position detection sensor **11** can still continue the detection of the position of the printing apparatus **1** as long as the amount of the lift is within a predetermined range. The downstream position detection sensor **11** can follow the print medium P and continue the position detecting operation as with the case where the body of the printing apparatus **1** gets tilted as illustrated in FIG. **8**A or as with the case where the printing apparatus **1** gets lifted by the action of the line break legs **13** during a line break operation.

As described above, the Y-direction sensor support shaft **11***d* formed integrally with the downstream position detection sensor case **11***a* and having a rotation axis extending in the direction of the arrows DF is rotatably supported by the downstream sensor case support arm **60**. In this way, even if the printing apparatus **1** gets lifted or tilted, the position detecting operation can be continued. It is therefore possible to provide a manually scanned handheld printing apparatus capable of suppressing deterioration in printing quality.

Second Embodiment

A second embodiment of the present disclosure will be described below with reference to a drawing. Note that the basic configuration in the present embodiment is similar to that in the first embodiment, and the characteristic configuration will therefore be described below.

FIG. **9** is a view illustrating the downstream position detection sensor **11** and components around it in the present embodiment. Note that the upper unit **3** is omitted in the illustration of FIG. **9**. Like FIGS. **8**A and **8**B, FIG. **9** is a cross-sectional view of the downstream position detection sensor **11** as seen from the position indicated by the line VI-VI of FIG. **4**A. A sensor case guide groove (slide guide) **112** is a groove provided in a plate-shaped protrusion fixed to the lower unit case **14**. The downstream position detection sensor **11** is mounted to a rotatable slide-type downstream sensor case **113**. A sensor case supporting shaft **113***a* protrudes from the rotatable slide-type downstream sensor case **113** and fitted in the sensor case guide groove **112**. The sensor case supporting shaft **113***a* is movable in the ±Z directions but is restricted from moving in the ±X directions. The rotatable slide-type downstream sensor case **113** is configured to be capable of sliding straight in the ±Z directions and is supported to be rotatable about the sensor case supporting shaft **113***a* as a rotation center.

The rotatable slide-type downstream sensor case **113** and the sensor case guide groove **112** are made of such materials that frictional force therebetween is small so that smooth sliding movement can be achieved. Also, the rotatable slide-type downstream sensor case **113** is pressed toward the print medium P by a spring not illustrated.

Such a configuration allows for suppression of a slight displacement between the lower unit case **14** and the downstream position detection sensor case which may occur in the first embodiment as a result of a large upward or downward movement of the body of the printing apparatus **1**. Employing the configuration of the present embodiment also makes it possible to correctly detect the locus of movement during line break operations.

Third Embodiment

A third embodiment of the present disclosure will be described below with reference to drawings. Note that the basic configuration in the present embodiment is similar to that in the first embodiment, and the characteristic configuration will therefore be described below.

FIG. **10** is a view illustrating the downstream position detection sensor **11** in the present embodiment. X-direction sensor support shafts **11***e* are provided to be orthogonal to the Y-direction sensor support shaft **11***d*. A sensor fixing support frame **11***f* includes bearing portions for receiving the Y-direction sensor support shaft **11***d* at positions on the dashed and single-dotted line Y. Moreover, the X-direction sensor support shafts **11***e* are fixed to the outer side of the frame at positions on the dashed and single-dotted line X. The downstream position detection sensor case **11***a* is supported by the Y-direction sensor support shaft **11***d* and is therefore rotatable relative to the sensor fixing support frame **11***f* about the dashed and single-dotted line Y. The sensor fixing support frame **11***f* is supported by the X-direction sensor support shafts **11***e* and is therefore rotatable about the dashed and single-dotted line X inside the lower unit case **14**. In other words, in the present embodiment, the downstream position detection sensor case **11***a* is supported to be rotatable about the two axes, or the dashed and single-dotted lines X and Y.

With the above configuration, even if the printing apparatus **1** gets tilted, the downstream position detection sensor case **11***a* can be caused to follow the print medium P. This makes it possible to handle various changes in the posture of the printing apparatus **1**. As described above, the position detection sensor case may be supported to be rotatable about a plurality of axes.

Fourth Embodiment

A fourth embodiment of the present disclosure will be described below with reference to a drawing. Note that the basic configuration in the present embodiment is similar to that in the first embodiment, and the characteristic configuration will therefore be described below.

FIG. **11** is a view illustrating the printing apparatus **1** in a lifted state. Note that the upper unit **3** is omitted in the illustration of FIG. **11**. FIG. **11** is a cross-sectional view of the downstream position detection sensor **11** as seen from the position indicated by the line VI-VI of FIG. **4**A. FIG. **12** is a block diagram illustrating a configuration of the control unit **16** in the printing apparatus **1** in the present embodiment. In the present embodiment, the control unit **16** is based on the example described in the first embodiment and, in addition, connected to a body tilt sensor **209**. In the description of the first embodiment, even if the printing apparatus **1** gets tilted by a certain angle or lifted to a certain height, the downstream position detection sensor case **11***a* is caused to follow the print medium P to detect the moving amount of the printing apparatus **1**. Here, when the printing apparatus **1** gets tilted by a certain angle, the position of the printing apparatus **1** is known owing to the sensor's detection. However, the direction of ink ejection from the print head **4** is also tilted from the direction orthogonal to the printing surface of the print medium P. This leads to a possibility of misalignment of the image to be printed. To address this, the printing apparatus **1** can also be controlled to temporarily stop a printing operation when it gets tilted by a predetermined angle or more. A cause of the misalignment of the image to be printed and a method of the present embodiment for suppressing this image misalignment will be described below.

In FIG. **11**, the arrow **50** indicates the direction of detection of the downstream position detection sensor **11**. Also, the arrow **51** indicates the direction of ink ejection from the print head **4** in a state where the printing apparatus **1** is tilted. Assume that, in the middle of image forming, the distance between the direction of detection of the downstream position detection sensor **11** and the direction of ink ejection from the print head **4** on the printing surface of the print medium P in the scanning direction changes by a distance dx. In this case, the image printed from the point where the tilt started is squished or stretched, thereby deteriorating the image quality in the section to the point where the tilt is corrected. To address this, in the present embodiment, the body tilt sensor **209** (see FIG. **12**), which detects the tilt of the printing apparatus **1**, is included. When the printing apparatus **1** gets tilted by a predetermined angle or more, a printing operation is temporarily stopped based on the result of the detection by the body tilt sensor **209**. As the body tilt sensor **209**, a sensor using a MEMS technology, which can miniaturize a sensor device and achieve high accuracy, is preferable.

FIG. **13** is a flowchart illustrating a tilt detection process during a printing operation. The tilt detection process in the present embodiment will be described below using this flowchart. Note that a CPU **200** in the printing apparatus **1** performs the series of processes illustrated in FIG. **13** by loading program code stored in a ROM **202** to a RAM **201** and executing it. Alternatively, the functions of some or all of the steps in FIG. **13** may be implemented with hardware such as an ASIC or an electronic circuit. Meanwhile, the symbol "S" in the description of each process means a step in the flowchart.

In response to starting the tilt detection process in a printing operation, the CPU **200** determines in S**01** whether or not the angle output from the body tilt sensor **209** is more than a predetermined tilt angle. If the output angle is less than or equal to the predetermined angle, the CPU **200** proceeds to S**07**, in which the CPU **200** determines that the printing operation is to be continued, and terminates the processing. If the angle output from the body tilt sensor **209** is more than the predetermined tilt angle, the CPU **200** proceeds to S**02**, in which the CPU **200** temporarily stops the printing operation of ejecting the ink from the print head **4**. Then, the CPU **200** proceeds to S**03**, in which the CPU **200** notifies the operator of an alert that the body of the printing apparatus is tilted with an LED, a buzzer, and the like on the operation panel **204**. Thereafter, in S**04**, the CPU **200** determines whether the operator has noticed the abnormality and corrected the tilt of the body of the printing apparatus **1**.

If the tilt of the body of the printing apparatus **1** has been corrected to the original state, the CPU **200** proceeds to S**07**, in which the CPU **200** determines that the printing operation is to be continued, and terminates the processing. If the angle is not corrected, the CPU **200** proceeds to S**05**, in which the CPU **200** determines whether a predetermined time has elapsed. If the tilt angle does not return to the predetermined angle or less within the predetermined time, the CPU **200** determines that an operational problem has occurred and proceeds to S**06**, in which the CPU **200** assumes this situation as an error and determines that the printing operation is to be aborted, and terminates the processing. If the tilt angle returns to the predetermined angle or less, the CPU **200** proceeds to S**07**, in which the CPU **200** determines that the printing operation is to be continued, and terminates the processing. By performing such a tilt detection process during a printing operation, it is possible to minimize the deterioration in printing quality due to tilt of the body of the printing apparatus **1**.

Since the downstream position detection sensor **11** is in contact with the print medium P, the position of the printing apparatus **1** can be detected. Hence, in S**07**, the printing operation can be continued from a point where the tilt of the body of the printing apparatus **1** returns to the predetermined angle or less. Also, the configuration may be such that the printing apparatus **1** is scanned in the reverse direction to a predetermined position over the blank region appearing after the printed area PA due to stopping the printing operation in S**02**, and resumes the printing operation from the predetermined position. In this way, even if the body of the printing apparatus **1** gets tilted, it is possible to maintain good image quality and continue the printing operation without aborting it.

The embodiments described above may be implemented in combination as appropriate.

While the present disclosure has been described with reference to exemplary embodiments, it is to be understood that the disclosure is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures and functions.

This application claims the benefit of Japanese Patent Application No. 2021-125317 filed Jul. 30, 2021, which is hereby incorporated by reference wherein in its entirety.

What is claimed is:

1. A printing apparatus comprising:

a holding unit configured to be held by a user to move the printing apparatus;

a printing unit configured to print an image onto a print medium according to a movement of the printing apparatus;

a detection unit that detects a relative moving amount between the printing apparatus and the print medium; and

a shaft provided configured to support the detection unit swingably in a direction substantially orthogonal to a printing surface of the print medium to be printed.

2. The printing apparatus according to claim **1**, further comprising a guide unit that guides the movement of the printing apparatus, wherein

the detection unit and the guide unit are displaceable relative to each other in a direction substantially orthogonal to the printing surface.

3. The printing apparatus according to claim **1**, wherein the detection unit is provided to be capable of contacting the print medium.

4. The printing apparatus according to claim **1**, wherein the detection unit includes a first detection unit and a second detection unit.

5. The printing apparatus according to claim **4**, wherein the first detection unit and the second detection unit are disposed with the printing unit therebetween.

6. The printing apparatus according to claim **1**, further comprising an arm swingably supported by a shaft provided in a direction substantially parallel to the printing surface and substantially orthogonal to a moving direction in which the printing apparatus is moved during printing by the printing unit, wherein

the detection unit is supported to be swingable relative to the arm.

7. The printing apparatus according to claim **6**, wherein the shaft swingably supporting the arm is provided to be offset from a center of the printing apparatus in the moving direction to a side in the moving direction.

8. The printing apparatus according to claim **1**, further comprising a tilt detection unit that detects a tilt of the printing apparatus, wherein

printing by the printing unit is stopped based on a result of the detection by the tilt detection unit.

9. The printing apparatus according to claim **1**, wherein the detection unit is provided via a slide guide disposed on a body of the printing apparatus so as to enable sliding movement, and is provided to be capable of moving straight along the slide guide in a direction substantially orthogonal to the printing surface.

10. The printing apparatus according to claim **1**, wherein the detection unit is swingably supported by a shaft provided in a moving direction in which the printing apparatus is moved during printing by the printing unit.

11. The printing apparatus according to claim **1**, wherein the detection unit detects the relative moving amount by optically reading a characteristic of a surface of the print medium.

* * * * *